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Assessment of different soil properties of Mawkynrew block, Meghalaya, India

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Abstract

The present investigation was conducted to assess the different soil properties of Mawkynrew Block, Meghalaya, India. All together twenty-seven samples were taken from three profile depth i.e. 0-15 cm, 15-30 cm and 30-45 cm from three different villages for the analysis of Physico-Chemical properties of soil. Result shows that the texture varied from sandy clay loam to clay loam, soil colour shows dark brown to yellowish red in dry condition and from dark brown to dark greyish brown in wet condition., bulk density and particle density increases with an increase with depth, water holding capacity and percent pore space decreases with depth, and the soil are acidic and non – saline in nature. The organic carbon is high in content, low to medium in nitrogen content, medium in phosphorous and potassium content in all villages except for few. Exchangeable calcium and magnesium varies from low to medium. The available sulphur are high in content, Micronutrients are present in higher amount. All the micronutrient shows decreased trend with the soil depth Significant and non-significant difference of soil physico- chemical properties was observing both due to village and due to depth.

Keywords: Physico-chemical properties, nitrogen, phosphorous, potassium, Sulphur, calcium and magnesium, micronutrients, Mawkynrew block, Meghalaya

Introduction

Soils are medium in which crops grow to food. Soil is not only important for agriculture but also have more useful for living organisms. Soil physical properties also largely determine the soil, water and air supplying capacity to plants. The physical properties of the soil rely on upon the amount of shape, structure, size, pore spaces, organic matter and mineral composition of soil. These physical properties are soil texture, bulk density, particle density, percent pore space, water holding capacity, soil structure, soil colour. Soil chemical properties are the most important among the factors that determine the nutrient supplying power of the soil to the plants and microbes. The chemical reactions that occur in the soil affect processes leading to soil development and soil fertility build up. These chemical properties of the soil are the soil acidity, soil salinity, soil organic carbon, soil nitrogen, Cation Exchange Capacity, Base Saturation percentage.

The physical and chemical characteristics of soil play a major role in the plant's ability to extract water and nutrients. The knowledge of the physical and chemical properties of soil helps in managing resources while working with a particular soil (Tewari *et al.* 2016) [22].

Agriculture is the primary occupation of the people of Mawkynrew block. The people mostly practice bun and nur method which is a modified form of jhum and shifting cultivation commonly known as the slash and burn method of cultivation. The raised bed of bun is 1-1.25 m wide and 2-7 m long and the plots vary from 0.5 to 1.0 ha, and are cultivated for 3-4 years. The traditional agricultural system helps in improving soil quality through decomposition of plant materials left on soil (Jeeva *et al.* 2006) [11]. The climate of the area is directly influenced by south west monsoon and north east winter winds. Maximum temperature ranges 15° C to 25° C and minimum temperature is between 5° C up to 17 °C. The climate is moderate type with a pleasant summer and extreme cold in winter season. The annual relative humidity is between 70 to 85% annually. The average rainfall is about 2283 mm. The principal agricultural crops grown of the bun fields are potato, Cabbage, Tomato, Cauliflower maize.

Materials and Methods

The block is located about 46 Km away from the State Capital Shillong, and cover a total geographical area of comprising 346 km² of 71 villages. The geographical extend of the area

is 91° 55' to 91° 58' East longitude and 25° 15' to 25° 33' North Latitude. This research study includes three villages of Mawkyntrew block i.e. Thangsning, Thynroit and Laitkyrhong village. The surface area for the collection of soil was cleared out. A hole was dug in a "V" shaped with the help of a spade, depth was measured by using a meter scale. Unwanted materials were removed. Soil samples were taking from three depths i.e. 0-15cm, 15-30cm and 30-45cm. Three soil samples are taking from each farmer's field leading to the collection of 27 samples in total. After collection, the soil was spread in sheet and air dried at room temperature away from direct sunlight. The soil clods or lumps are broken down into a fine particle with wooden mallet. The soil sample was sieved with 2mm sieve. The soil sample were collected by coning and quartering method. The collected soil was kept in a clean and dry polythene bag. The soil was analyzed by using standard methods: texture by Bouyoucos Hydrometer method (Bouyoucos, 1927) [2], Soil colour by Munsell soil colour chart (Munsell, 1954) [16]. Specific gravity by relative density bottle or Pycnometer (Black, 1965) [1]. For bulk density, particle density, water holding capacity and percentage pore space by Graduated 100 ml measuring cylinder method (Muthuval *et al.*, 1992) [17], Soil pH by Digital pH Meter (Jackson 1958) [10], Electrical Conductivity by Digital EC Meter (Wilcox 1950) [24], Organic Carbon by Wet Oxidation Method (Walkley and Black 1947) [23], Available Nitrogen by Alkaline Permanganate method by using Kjeldahl Flask (Subbiah and Asija 1956) [20], Available Phosphorous by Spectrometric method Olsen (alkaline neutral) and Bray (acidic) (Olsen and Bray 1954) [18] Available Potassium by Flame Photometer Method using ammonium acetate solution

(Toth and Prince 1949) Available sulphur by Turbidimetric Method (Chesnin and Yien 1950) [4] exchangeable Calcium and Magnesium by 1N Neutral Ammonium Acetate Saturation/ EDTA Method (Cheng and Bray 1951) [5] Available Iron, Zinc, Manganese and Copper by DTPA method (Lindsay and Norvell 1978)

Results and Discussion

Physical Properties

As presented in table 1,2 and 3. The texture of the soil of Mawkyntrew block varied from sandy clay loam to clay loam. Similar results were also reported by Das *et al.* (2015) [7]. Soil colour shows dark brown to yellowish red in dry condition and from dark brown to dark greyish brown in wet condition. Bulk density increase with depth ranged from 0.86 to 1.15 Mg m⁻³ and particle density ranged from 2.0 to 2.85 Mg m⁻³. The bulk density and particle density increases with the increase in soil depth this due to presence of organic matter and clay content in surface soils. Higher compaction in the sub surface soils may be due to absence of cultivation (Dutta *et al.*, 2015) [8] and (Lamare and Singh 2017) [14]. Water holding capacity ranged from 34.09 to 66.66%. The surface layer has higher percentage of water holding capacity than the sub-surface layer this may due to the mechanical composition and organic matter content in soils (Dutta *et al.*, 2015) [8] and (Lamare and Singh 2017) [14] and pore space percentage from 44.19 to 62.98 % Pore space decreases with an increase in depth. Decrease in pore space is attributed to increase in compaction in the soil. (Lamare and Singh 2017) [14]. Specific gravity in soils of different villages range from 1.48 to 2.30 These findings were in line with that of Pradhan *et al.*, (2020) [19]

Table 1: Soil texture and Soil Colour of Mawkyntrew Block, Meghalaya, India

Village Name	Soil Texture	Soil Colour	
		Range (Dry condition)	Range (Wet Condition)
Thangsning S ₁	Sandy clay loam	Dark yellowish brown – Dark brown	Dark brown
Thangsning S ₂	Sandy loam	Dark brown – Dark yellowish brown	Dark brown
Thangsning S ₃	Sandy clay loam	Dark brown – Dark yellowish brown	Dark brown
Thynroit S ₄	Sandy clay loam	Yellowish red	Yellowish red – Reddish yellow
Thynroit S ₅	Sandy clay loam	Yellowish red – reddish yellow	Yellowish red – Reddish brown
Thynroit S ₆	Sandy clay loam	Reddish yellow- Yellowish red	Dark reddish brown – Yellowish red
Laitkyrhong S ₇	Loamy Sand	Dark yellowish brown – Dark brown	Dark brown
Laitkyrhong S ₈	Clay loam	Dark greyish brown – Dark brown	Very Dark greyish brown – Dark brown
Laitkyrhong S ₉	Clay loam	Dark brown – Dark yellowish brown	Very Dark greyish brown – Dark brown

Table 2: Evaluation of bulk density, particle density and water holding capacity of soil of Mawkyntrew block, Meghalaya

Village Name	Bulk Density (Mg m ⁻³)			Particle Density (Mg m ⁻³)			Water Holding Capacity (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsning									
S ₁	1.05	1.11	1.13	2.01	2.20	2.22	56.41	48.64	47.36
S ₂	1.00	1.05	1.10	2.00	2.21	2.22	55.55	54.76	51.11
S ₃	1.00	1.05	1.10	2.00	2.22	2.25	51.11	46.66	44.18
Thynroit									
S ₄	1.05	1.10	1.15	2.22	2.25	2.85	55.26	53.84	54.76
S ₅	1.10	1.11	1.13	2.31	2.25	2.85	58.33	62.16	66.66
S ₆	1.05	1.10	1.12	2.22	2.50	2.85	55.55	59.45	66.66
Laitkyrhong									
S ₇	0.90	1.10	1.05	2.21	2.85	2.85	56.41	55.55	51.28
S ₈	0.86	1.00	1.11	2.52	2.85	2.85	54.05	51.11	38.63
S ₉	1.09	1.12	1.15	2.25	2.85	2.85	52.27	42.85	34.09
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to village	S	0.01685	0.10231	NS	0.7787	0.00105	S	2.078905	0.010962
Due to depth	S	0.02828	0.00014	NS	0.1308	0.00009	NS	0.368345	0.88769

Table 3: Estimation of pore space (%) and specific gravity

Village Name	Pore Space Percentage (%)			Specific Gravity		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsning						
S ₁	54.60	50.00	48.12	2.21	1.95	1.82
S ₂	48.01	44.51	40.05	2.82	1.97	1.92
S ₃	50.12	48.25	46.51	1.88	1.59	1.57
Thynroit						
S ₄	54.54	52.70	50.06	1.75	1.71	1.69
S ₅	53.36	50.84	48.21	2.02	1.94	1.63
S ₆	53.42	52.70	49.50	1.69	1.63	1.48
Laitkyrhong						
S ₇	59.61	54.95	51.78	1.90	1.80	1.60
S ₈	66.66	63.21	59.07	2.31	2.00	1.81
S ₉	64.05	63.06	50.16	2.21	2.14	1.92
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Village	NS	2.015	2.19150	S	0.0714	0.02069
Due to Depth	NS	0.7286	7.27547	NS	0.1079	0.05601

Chemical Properties

As depicted in table 4. The soil pH of different village of Mawkynrew Block varies between 4.5 to 6.2 with a mean value of 5.7. In general, pH decreased with increase in soil depth. The pH of the soil is strongly acidic to moderate acidic in nature. The moderate to strong acid condition may be attributed to leaching of bases due to heavy rainfall and accumulation of acid forming cations like Al, Fe and Mn leading to increased acidity (Dutta *et al.*, 2015) [8]. Similar finding were also reported by Laxminarayan (2010) [15], Jena *et al.* (2015) [12] and Lamare and Singh (2017) [14]. Electrical Conductivity (dS m⁻¹) of different villages of Mawkynrew

Block range from 0.11 to 0.43 dS m⁻¹ and the mean value is given in table 3. It has also been observed that electrical conductivity of soils of the study area is non saline and is good for crop production. Similar results are also reported by Das *et al.* (2020) [6]. Soil organic carbon (%) of the soil samples are varies from 0.36 to 1.24 % with a mean value of 0.85% as shown in table 3. The surface layer had higher organic C as compared to sub surface layer which could be due to deposition of leaf litter and residues (Dutta *et al.* 2015) [8]. Similar findings were also reported by Jena *et al.* (2015) [12] and Bhuyan *et al.* (2015) [3].

Table 4: Estimation of soil pH (1:2) EC (1:2) (dS m⁻¹), OC (%)

Village Name	pH			EC (dS m ⁻¹)			OC (%)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsning									
S ₁	5.2	4.6	4.5	0.51	0.32	0.15	1.24	0.98	0.69
S ₂	6.2	6.1	6.0	0.43	0.23	0.11	1.15	1.14	1.05
S ₃	6.3	5.5	5.1	0.40	0.36	0.24	0.96	0.83	0.52
Thynroit									
S ₄	5.7	5.5	5.3	0.43	0.21	0.18	0.98	0.82	0.61
S ₅	5.7	5.5	5.1	0.42	0.30	0.12	0.99	0.73	0.41
S ₆	6.1	5.8	5.6	0.43	0.25	0.14	1.13	1.09	0.92
Laitkyrhong									
S ₇	6.1	6.0	5.5	0.55	0.42	0.26	1.04	0.98	0.63
S ₈	6.2	6.1	6.0	0.44	0.16	0.12	0.72	0.54	0.36
S ₉	6.0	5.9	5.7	0.43	0.21	0.13	0.94	0.72	0.65
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Village	S	0.13721	2.00562	S	0.01682	0.004268	S	0.05935	9.32791
Due to Depth	S	0.17633	0.00004	S	0.08452	7.095401	S	0.10744	3.47471

Primary Nutrients

As portrayed in table 5. The available nitrogen content in the study area ranged from 154.90 to 513.01 Kg ha⁻¹ with a mean value of 350.09 Kg ha⁻¹. Similar report was given by Goswami *et al.* (2020) [9]. Phosphorous present in soil samples of Mawkynrew block varies from 13.1 to 104.1 Kg ha⁻¹ with a

mean value of 24.26 (Kg ha⁻¹). These results are similar to the findings of Goswami *et al.* (2020) [9] and Das *et al.* (2020) [6] and the potassium found in soils of different villages of Mawkynrew Block ranged from 11.22 to 123.50 Kg ha⁻¹ and with a mean value of 59.26 Kg ha⁻¹. Similar findings were reported by Das *et al.* (2020) [6]

Table 5: Evaluation of Available Nitrogen Kg ha⁻¹, Available Phosphorous (Kg ha⁻¹) and Available Potassium (Kg ha⁻¹)

Village Name/Site	N (Kg ha ⁻¹)			P (Kg ha ⁻¹)			K (Kg ha ⁻¹)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsning									
S ₁	498.31	452.68	362.01	21.5	19.7	13.1	56.13	33.68	22.45
S ₂	502.38	487.27	373.09	57.1	30.6	21.8	67.36	44.90	11.22
S ₃	421.24	385.05	361.01	46.8	30.5	26.7	78.59	33.68	16.84
Thynroit									

S ₄	424.39	387.16	346.17	104.1	60.3	57.4	101.04	56.13	33.68
S ₅	513.01	468.40	397.18	24.3	22.0	19.9	89.81	78.59	44.90
S ₆	383.52	325.92	296.42	98.3	95.2	90.9	112.27	89.81	56.13
Laitkyrhong									
S ₇	226.34	217.81	179.32	45.4	43.1	42.0	67.36	44.90	22.45
S ₈	254.63	198.07	154.90	47.1	35.7	32.9	78.59	44.90	33.68
S ₉	361.09	278.05	196.91	36.3	35.2	33.8	123.50	101.04	56.13
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Village	S	33.4650	1.36670	S	8.20426	2.6630	S	6.85520	8.68550
Due to Depth	S	29.5678	1.62563	S	4.46230	0.0079	S	15.3084	1.37049

Secondary Nutrients

As illustrated in table 6. The Exchangeable Calcium and Magnesium of the soil samples ranges from 2.17 to 9.08 [C mol (p⁺) kg⁻¹] and 0.89 to 5.27 [C mol (p⁺) kg⁻¹] with mean value of 4.86 and 2.57 respectively which are given in table 5.

The calcium and magnesium content in the soil may be affect by the amount of rainfall intensity. The sulphur of soil in the study area varies from 4.85 to 63.80 mg Kg⁻¹. The available sulphur was found low to high in the entire study area. Similar findings were reported by Sen *et al.* (2017) [21].

Table 6: Estimation of Secondary nutrients status of soil of Mawkynew Block

Village Name	Ex. Ca [C mol (p ⁺) kg ⁻¹]			Ex. Mg [C mol (p ⁺) kg ⁻¹]			S (mg Kg ⁻¹)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsnng									
S ₁	9.08	7.61	4.91	8.21	4.00	3.61	21.58	15.31	9.01
S ₂	4.62	4.35	2.53	2.73	1.84	1.52	63.20	40.31	21.80
S ₃	5.12	3.63	2.17	2.17	1.62	1.43	46.86	32.11	27.96
Thynroit									
S ₄	6.23	5.77	4.09	5.21	2.83	2.40	10.40	10.21	10.01
S ₅	4.91	4.09	3.81	3.49	0.25	0.17	33.06	24.91	19.82
S ₆	5.11	4.35	3.62	4.31	1.09	0.98	37.25	27.18	19.82
Laitkyrhong									
S ₇	8.21	8.07	4.09	3.08	1.43	0.97	15.09	9.07	6.01
S ₈	5.29	3.67	2.53	2.81	1.43	0.97	19.74	10.24	6.09
S ₉	6.81	3.47	3.13	4.27	3.65	0.89	8.03	6.92	4.85
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Village	S	0.43797	0.00015	S	0.40375	0.74895	S	4.14362	0.00029
Due to Depth	S	0.78831	6.08597	S	0.00108	0.000003	S	4.49312	0.00041

Micronutrients

As represented in table 7. The micronutrient content in the soil samples of Mawkynew Block was found that Fe, Mn, Cu and Zn ranged from 1.47 to 22.01 ppm, 4.18 to 6.34 ppm, 1.39 to 17.36 ppm and 0.12 to 15.35 ppm respectively. The range and mean value of the micronutrients are given in table 6. The accumulation of Fe content is high in range which

attribute to high rainfall and leaching. The availability of Mn was mostly attributed to strong acidity and the soil organic carbon whereas, the accumulation of Cu in the soil may be due to higher clay particle and organic matter content and soil order may also affect the Zn content in the soil. These lines were also find by Jena *et al.*, (2015) [12] and Goswami *et al.*, (2020) [9]

Table 7: Estimation of Available Micronutrients

Village Name	Fe (ppm)			Mn(ppm)			Cu (ppm)			Zn (ppm)		
	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm	0-15 cm	15-30 cm	30-45 cm
Thangsnng												
S ₁	10.72	7.21	1.47	5.07	4.61	4.18	4.21	3.80	2.56	12.41	11.21	0.23
S ₂	15.22	11.08	8.89	4.53	4.40	4.36	9.96	5.71	2.38	9.50	7.32	6.09
S ₃	22.01	21.13	20.01	6.18	6.03	5.75	7.49	6.28	5.49	7.01	3.01	0.45
Thynroit												
S ₄	10.61	9.31	8.54	6.34	5.58	5.21	3.88	3.81	2.61	4.51	2.12	0.15
S ₅	12.35	9.21	7.32	6.01	5.42	5.11	7.20	6.93	6.40	0.31	0.26	0.12
S ₆	19.75	16.03	14.89	4.78	4.70	4.63	14.50	9.23	5.90	0.62	0.41	0.35
Laitkyrhong												
S ₇	16.33	7.01	3.52	5.12	5.04	4.83	17.96	8.99	1.39	13.21	11.32	9.91
S ₈	10.01	8.21	4.21	5.82	5.30	4.32	5.28	3.14	2.58	15.35	10.52	7.31
S ₉	8.09	7.31	7.11	5.62	5.50	5.48	3.37	2.90	2.62	10.21	9.81	6.21
	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%	F- test	SEm (±)	CD at 5%
Due to Village	S	1.6233	1.4881	S	0.1976	0.00001	S	0.8806	0.0354	S	1.4161	0.0001
Due to Depth	S	1.5832	0.0001	S	0.1818	0.00044	S	1.3476	3.6337	S	1.3677	0.0010

Conclusion

We conclude the soil of Mawkynew block have good physical condition, the amount of macro nutrient element is

low to medium and the micro nutrient are high. The deficiency of nutrients can be mitigated by the use of some inorganic fertilizers or organic fertilizers. Organic farming not

only improves the physical condition of the soil but also enriches the soil with essential plant nutrients at low costs of production. By studying the soil sample, productivity of potato, peas, cabbage, soybean, maize, rice are most suitable based on the soil analyse results.

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