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Characterization of the Soils of SASRD, Nagaland University Research Farm, Medziphema, Nagaland

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ABSTRACT

Fifty two soil samples (26 surface and 26 sub-surface) were collected from thirteen departmental research farm of the SASRD (School of Agricultural Sciences and Rural Development), Nagaland University, Medziphema, Nagaland and analyzed for some important physico-chemical properties, fertility status and soil acidity components. Average sand, silt and clay fractions of the surface and sub-surface soils were 47.6, 30.1 and 22.1% and 45.0, 27.8 and 27.1%, respectively, soils indicated clay loam, loam, sandy loam and sandy clay loam textural classes and soils of both layers were identical in texture. Surface soils indicated low bulk density and high particle density and porosity. Soils of the research farm were strong to moderate acidic in reaction and normal in soluble salts and those of the sub-surface soils were more acidic. Cation exchange capacity (CEC) of the soils was quite low. Surface soils showed more CEC than those from sub surface soils. Mean base saturation for surface and sub-surface soils was reported 18.19 and 16.87%, respectively. The soils were high in organic carbon, medium in available nitrogen, potassium and sulfur and low in available phosphorus. High quantum of OC, available N, P, K and S were reported in the surface soils. Average exchangeable calcium and magnesium content in surface and sub-surface soils were reported 1.27, 0.67 and 1.23, 0.63 cmol kg^{-1}, respectively. Total potential acidity of the soils was quite high and accounted for severe acidity problem in these soils and ranged from 10.65 to 13.85 and 10.27 to 12.56 cmol kg^{-1} in the surface and sub-surface soils, respectively. High values of pH dependent acidity, exchangeable H^+ and total potential acidity were recorded in surface soils while exchange acidity and exchangeable Al^{3+} were more in sub-surface soils. The pH dependent acidity and exchange acidity contributed 80.9, 15.5% in surface and 82.2, 17.8% in sub-surface soils, respectively to total potential acidity. Lime requirement of the soils was quite high and surface soils showed more lime requirement. Available N, P and S exhibited significant positive correlation with organic carbon, N and P with pH and N with BD and CEC. Available K manifested significant positive correlation with clay and CEC and negative with pH. Components of acidity and lime requirement had negative significant correlation with pH. Lime requirement had significant negative correlation with pH. Therefore, it is need of hour to develop cost effective suitable remedial counter measures other than liming.

Keywords Nagaland, SASRD farm, Physico-chemical properties, Fertility status, Soil acidity components.

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INTRODUCTION

Soil, the source of an infinite life is the most vital and precious natural resource, and not renewable in a short time. The soil is one of the key components of the agricultural production system and its quality is governed by physico-chemical characteristics and nutrient supplying capacity which ultimately reflected through crop productivity. Soil fertility is a dynamic natural property and it can change under the influence of natural and human induced factors. Soil fertility fluctuates throughout the growing season each year due to alteration in the quantity and availability of mineral nutrients by the addition of fertilizers, manure, compost, mulch and lime in addition to leaching. Hence evaluation of fertility status of the soils of an area or region is an important aspect in the context of sustainable agriculture (Singh and Mishra 2012). Soil acidity is one of the main reasons for nutrition depletion as well as causes of fertility decline that affects crop production.

The research farm of SASRD is hilly, undulating and used for different purposes, most of the fields have been used for conducting various research investigation which leads to declination in their fertility status; the physico-chemical properties of the farm may vary from different land uses. The soil condition is of great importance because it is a universal medium for plant growth, which supplies essentials nutrients to the plants (Sangtam *et al.* 2017). But due to excess use of agro-inputs, the soil properties are being changed (Kamble *et al.* 2013). Different land use patterns and cropping patterns play a vital role in governing the soil characteristics, nutrient dynamics and soil fertility. Soils under particular cropping pattern for long period may affect physico-chemical properties which may modify fertility status and nutrient availability to plants. The assessment of the physico-chemical properties, nutrient status and nature of acidity of the soils of important cropping patterns may have significant importance in future soil health management strategies. Therefore, considering the above mentioned fact, an experiment was carried out to study the characterization of the soils of School of Agricultural Sciences and Rural Development (SASRD), Medziphema, Nagaland.

MATERIALS AND METHODS

Present study was conducted during 2019-20 to study properties of the soils under research activities of the various departments of the SASRD. A total of fifty two soil samples (26 surface (0-20 cm and 26 sub-surface (20-40 cm)) were collected from thirteen departmental research farm of the School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema. Four samples (two surface and two sub-surface) were collected from two locations of each departmental farm. Collected soil samples were air dried and grinded with the help of wooden hammer and analyzed for different properties. Processed soil samples were analyzed for CEC (Chapmam 1965). Bulk density, particle density, porosity, soil texture and forms of soil acidity were determined using standard method of analysis described by Baruah and Barthakur (1997). Soil pH, organic carbon, available N and available K were analyzed following standard methods (Jackson, 1973). For available P, soil samples were extracted with Bray P-1 extractant (Bray and Kurtz 1945) and phosphorus content in soil extract was determined as described by Jackson (1973). Available sulfur was estimated by turbidimetric method (Chesnin and Yien 1951). Exchangeable calcium and magnesium was extracted using neutral ammonium acetate and determined by Versenate method (Gupta 2007). Simple correlation coefficients were worked out to correlate physico-chemical characteristics of soils with available nutrients and forms of soil acidity.

Description of study area

SASRD, Nagaland University campus is situated in Medziphema sub-division of Dimapur district, which located 44 km from the capital city of Kohima and 33 km from Dimapur on Dimapur- Kohima national highway. Geographical location of SASRD is 25^0 45' 37.1736" N latitude and 930 52' 59.2392" E longitudes, lying at an altitude of about 360 m above mean sea level. Medziphema has a sub-humid tropical climate with high relative humidity, moderate temperature with medium to high rainfall. The average rainfall varies between 2000-2500 mm. The mean temperature ranges from 21 to 32^0C during summer and winter from 10-15^0C.

Table 1. Soil texture, densities and porosity of the soils of SASRD research farm.

		0 – 20 cm depth				20 – 40 cm depth				Bulk density (mg m^{-3})		Particle density (mg m^{-3})		Porosity (%)	
Sl. No.	Farm site	Sand (%)	Silt (%)	Clay (%)	Texturl class	Sand (%)	Silt (%)	Clay (%)	Textural class	0 – 20 cm	0 – 20 cm	0 – 20 cm	0 – 20 cm	0 – 20 cm	0 – 20 cm
1	AGR	44.4	25.8	29.7	cl	42.0	23.1	34.8	cl	1.08	1.18	2.23	2.19	49.6	46.1
2	ENT	45.7	35.2	19.0	l	41.4	32.1	26.3	l	1.00	1.05	2.21	2.19	54.8	51.9
3	SWC	42.6	26.5	30.8	cl	40.0	24.3	35.5	cl	1.01	1.05	2.22	2.19	54.3	52.1
4	LPM	57.1	28.1	14.6	sl	53.3	26.6	20.0	sl	1.09	1.11	2.17	2.14	49.8	47.8
5	AV	51.2	34.5	14.2	sl	49.9	32.2	17.7	sl	1.06	1.08	2.15	2.13	50.8	49.1
6	AS	53.2	31.5	15.1	sl	50.0	27.7	22.2	sl	1.08	1.11	2.26	2.25	51.8	50.2
7	PLP	50.1	22.9	26.9	scl	47.8	20.7	31.3	scl	1.03	1.10	2.23	2.20	53.9	49.7
8	GPB	48.2	30.7	20.9	l	46.0	28.0	25.9	l	1.02	1.10	2.15	2.13	52.3	49.7
9	AGE	46.4	33.3	20.2	l	44.1	30.4	25.3	l	1.02	1.07	2.22	2.20	54.7	50.9
10	FS	46.5	31.2	22.1	l	43.9	29.1	26.8	l	1.02	1.06	2.13	2.11	53.8	49.8
11	FL	45.2	32.1	22.6	l	43.7	30.0	26.2	l	1.08	1.12	2.17	2.15	50.3	48.4
12	VS	45.0	34.4	20.5	l	41.2	32.7	25.9	l	1.06	1.11	2.21	2.19	52.8	49.2
13	UF	43.7	25.5	30.6	cl	41.6	23.3	34.4	cl	0.99	1.01	2.24	2.23	49.8	48.0
Minimum		42.6	22.9	14.2	-	40.0	20.7	17.7	-	0.99	1.01	2.13	2.11	49.6	47.8
Maximum		57.1	35.2	30.8	-	53.3	32.2	35.5	-	1.09	1.18	2.26	2.25	54.8	52.1
Mean		47.6	30.1	22.1	-	45.0	27.8	27.1	-	1.04	1.09	2.20	2.18	52.2	49.5

AGR- Agronomy, ENT- Entomology, SWC- Soil and Water Conservation, LPM- Livestock Production and Management, AV- AICRP(Vegetables), AS- AICRP(Soybean), PLP- Plant Pathology, GPB- Genetics and Plant Breeding, AGE- Agricultural Engineering, FS- Fruit Science, FL- Floriculture, VS- Vegetable Science, UF- Undisturbed Forest.
cl- Clay Loam, l- Loam, sl- Sandy Loam, scl- Sandy Clay Loam.

RESULTS AND DISCUSSION

Physico-chemical properties and organic carbon

The sand, silt and clay content in surface soils of SASRD research farm varied from 42.6 to 57.1%, 22.9 to 35.2% and 14.2 to 30.8% with a mean value of 46.6, 30.1 and 22.1%, respectively, while in sub-surface soils these particles varied from 40.0 to 53.3, 20.7 to 32.2 and 17.7 to 35.5% with a mean value of 45.0, 27.8 and 27.1%, respectively (Table 1). Comparatively higher clay content was recorded in sub-surface soils. Surface and sub-surface soils were identical in texture. Bulk density of the surface and sub-surface soils varied from 0.99 to 1.09 and 1.01 to 1.18 mg m^{-3} with an average value of 1.04 and 1.09 mg m^{-3}, respectively. Particle density of surface and sub-surface soils ranged from 2.13 to 2.26 and 2.11 to 2.25 mg m^{-3} with an average value of 2.20 and 2.18 mg m^{-3}, respectively. Porosity of the surface and sub-surface soils of SASRD farm was observed in the range of 49.6 to 54.8 and 47.8 to 52.1% with a mean value of 52.2 and 49.5%, respectively. Remarkable variation did not report in bulk density, particle density and porosity of the soils of SASRD farm. Less bulk density was recorded in surface soils might be due to higher amount of organic carbon in surface soils.The pH value of the surface and sub-surface soils of different departmental farm varied from 4.82 to 5.26 and 4.61 to 5.05 with a mean value of 5.10 and 4.81, respectively indicating that the soils of the SASRD research farm are strong to moderately acidic in reaction (Table 2). Sub-surface soils indicated less pH value than surface soils. Similar findings have also been reported by Konyak *et al*. (2020). Electrical conductivity (EC) of surface and sub-surface soils ranged from 0.13 to 0.31 and 0.10 to 0.24 dSm^{-1} with a mean value of 0.19 and 0.14 dSm^{-1}, respectively. Slightly higher value of EC was observed in surface soils might be due to application of fertilizers and chemicals in surface soils. Cation exchange capacity (CEC) of surface and sub-surface soils. ranged from 9.80 to 15.88 and 8.05 to 12.10 cmol(p+) kg^{-1} with an average of 11.45 and 9.65 cmol (p+) kg^{-1}, respectively. Irrespective of land use patterns of various departmental farms, the soils were low in CEC that might be presence of low CEC clay minerals viz; kaolinite and illite dominantly in the soils of North Eastern states.

Table 2. The pH, EC, CEC, BS and organic carbon content of the soils of SASRD research farm.

Sl. No.	Farm site	pH		EC (dSm^{-1})		CEC [cmol (p^+) kg^{-1}]		BS (%)		OC (g kg^{-1})	
		0-20 (cm)	20-40 (cm)	0-20 (cm)	20-40 (cm)	0-20 (cm)	20-40 (cm)	0-20 (cm)	20-40 (cm)	0-20 (cm)	20-40 (cm)
1	AGR	5.06	4.72	0.17	0.12	12.80	11.65	18.64	17.63	10.84	9.15
2	ENT	5.08	4.86	0.25	0.16	11.23	9.31	18.82	17.53	14.90	9.65
3	SWC	5.05	4.85	0.25	0.18	13.68	9.81	17.46	16.40	14.25	9.95
4	LPM	5.30	5.05	0.17	0.12	10.00	8.48	19.99	18.46	12.95	9.75
5	AV	5.08	4.77	0.17	0.14	9.80	8.40	15.81	13.59	11.91	9.75
6	AS	4.99	4.76	0.15	0.12	10.20	8.05	15.11	14.74	13.75	11.70
7	PLP	5.19	4.87	0.31	0.24	11.94	9.65	19.22	18.19	12.80	9.20
8	GPB	5.12	4.82	0.17	0.12	10.35	9.91	18.23	16.97	12.05	7.85
9	AGE	5.19	4.99	0.16	0.12	10.61	9.25	17.97	16.63	10.25	7.55
10	FS	5.26	4.76	0.16	0.10	11.68	9.98	18.78	16.61	13.10	8.95
11	FL	5.01	4.70	0.16	0.13	10.55	9.87	18.60	17.50	11.75	4.70
12	VS	5.15	4.71	0.19	0.13	9.96	8.98	19.60	17.90	10.40	6.75
13	UF	4.82	4.61	0.13	0.10	15.88	12.10	18.19	17.16	17.15	9.55
Minimum		4.82	4.61	0.13	0.10	9.80	8.05	15.11	13.59	10.25	4.70
Maximum		5.26	5.05	0.31	0.24	15.88	12.10	19.99	18.46	17.15	11.70
Mean		5.10	4.81	0.19	0.14	11.45	9.65	18.19	16.87	12.78	8.81

AGR- Agronomy, ENT- Entomology, SWC- Soil and Water Conservation, LPM- Livestock Production and Management, AV- AICRP(Vegetables), AS- AICRP(Soybean), PLP- Plant Pathology, GPB- Genetics and Plant Breeding, AGE- Agricultural Engineering, FS- Fruit Science, FL- Floriculture, VS- Vegetable Science, UF- Undisturbed Forest.

Higher CEC was observed in undisturbed forest soils which might be due to high organic carbon content in these soils. Furthermore, it was reported that surface soils showed more CEC than sub-surface ones might be due to high amount of organic carbon in surface soils (Sarangthem *et al*. 2018). Base saturation of surface and sub-surface soils varied from 15.11 to 19.99 and 13.59 to 18.46% with a mean value of 18.19 and 16.87%, respectively. Comparatively higher value of base saturation was observed in surface soils might be due high organic carbon content. Wide variation in the soil organic carbon (SOC) content of the soils of different department was observed. The SOC content of the surface soils ranged from 10.25 to 17.15 g kg^{-1} with an average value of 12.78 g kg^{-1} while in sub-surface soils it varied from 4.70 to 11.70 g kg^{-1} with a mean value of 8.81 g kg^{-1}. In sub-surface soils OC was reduced by 31.0% in comparison to surface soils. Variation in agronomic practices such as tillage and crop removal during harvest by various departments caused differences in SOC status of the soils. Undisturbed forest ecosystem tended to promote SOC accumulation possibly due to incorporation of huge quantity of forest litter to the soil. Incorporation of more organic residues in surface soils might be reason of high organic carbon status of surface soils. These results are in agreement with those of Sangtam *et al.* (2017), Bordoloi and Sharma (2022).

Fertility status

Available N and P content in surface and sub-surface soils ranged from 269.6 to 545.3 and 225.7 to 407.1 and 14.2 to 19.7 and 13.6 to 17.7 kg ha^{-1}, with a mean value of 359.5, 308.3 and 17.0, 15.2 kg ha^{-1}, respectively (Table 3). Despite high in organic carbon, medium N content might be due to low mineralization rate in cold climatic condition and acidic soil environment. Higher amount of available nitrogen and phosphorus was recorded in undisturbed forest soils, might be due to high amount of organic carbon in these soils. High amount of available N and P was recorded in surface soils might be due to high organic matter content. Variation in extraction of these nutrients by crops and cropping systems might be reason of variation in available N and P content of the soils of different departments. Available K and sulfur content in surface soils varied from 140.1 to 228.2 and 17.1 to 28.1 kg ha^{-1} and in sub surface soils from 136.9 to 212.8 and 14.8 to 25.9 kg ha^{-1}, respectively. Average values of these nutrients in surface and sub-surface soils were reported 169.3, 159.7 kg ha^{-1}

Table 3. Fertility status of the soils of SASRD research farm.

Sl. No.	Farm site	Available nutrients (kg ha^{-1}). Nitrogen 0-20 cm	Nitrogen 20-40 cm	Phosphorus 0-20 cm	Phosphorus 20-40 cm	Potassium 0-20 cm	Potassium 20-40 cm	Sulfur 0-20 cm	Sulfur 20-40 cm	Ex Ca^{2+} (cmol kg^{-1}) 0-20 cm	Ex Ca^{2+} 20-40 cm	Ex Mg^{2+} (cmol kg^{-1}) 0-20 cm	Ex Mg^{2+} 20-40 cm
1	AGR	294.7	244.6	14.7	13.6	203.3	191.8	17.8	15.9	1.25	1.22	0.62	0.60
2	ENT	439.0	357.1	18.1	16.7	156.2	152.2	27.7	25.1	1.30	1.26	0.73	0.64
3	SWC	400.6	377.3	16.2	14.7	207.5	193.8	26.9	23.0	1.28	1.25	0.73	0.70
4	LPM	365.7	319.8	17.8	15.8	140.1	136.9	24.2	21.1	1.30	1.26	0.65	0.62
5	AV	340.6	308.3	15.9	14.5	145.3	140.4	22.1	19.6	1.29	1.25	0.75	0.65
6	AS	381.4	351.0	14.2	13.7	148.4	146.5	25.6	22.3	1.25	1.21	0.68	0.63
7	PLP	343.4	309.5	17.7	13.6	165.1	142.7	17.1	14.8	1.30	1.27	0.55	0.52
8	GPB	338.6	301.0	16.7	16.2	154.1	147.8	22.1	19.7	1.21	1.17	0.57	0.53
9	AGE	269.6	225.7	16.8	14.2	159.2	146.5	19.2	17.5	1.27	1.23	0.63	0.60
10	FS	371.0	293.4	17.9	15.6	171.3	158.8	25.5	21.0	1.22	1.18	0.71	0.66
11	FL	302.0	274.4	17.9	16.2	169.4	156.0	22.9	19.9	1.25	1.21	0.65	0.65
12	VS	282.2	238.3	16.9	14.7	152.5	149.4	19.0	17.3	1.23	1.19	0.62	0.59
13	UF	545.3	407.1	19.7	17.7	228.2	212.8	28.1	25.9	1.31	1.27	0.84	0.79
Minimum		269.6	225.7	14.2	13.6	140.1	136.9	17.1	14.8	1.21	1.17	0.55	0.52
Maximum		545.3	407.1	19.7	17.7	228.2	212.8	28.1	25.9	1.31	1.27	0.84	0.79
Mean		359.5	308.3	17.0	15.2	169.3	159.7	22.0	20.2	1.27	1.23	0.67	0.63

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and 22.0, 20.2 kg ha^{-1}, respectively. High amount of K and S in surface soils may be due to more organic carbon content in these soils. Similar results have also been reported by Tsanglao *et al.* (2014), Odyuo,

Table 4. Acidity components of the soils of SASRD research farm.

Sl. No.	Farm site	Acidity components (cmol kg^{-1}) PDA 0-20 cm	PDA 20-40 cm	Ex acidity 0-20 cm	Ex acidity 20-40 cm	Ex. Al^{3+} 0-20 cm	Ex. Al^{3+} 20-40 cm	Ex H^{+} 0-20 cm	Ex H^{+} 20-40 cm	TPA 0-20 cm	TPA 20-40 cm	LR at pH 6.4 (t ha^{-1}) 0-20 cm	LR at pH 6.4 20-40 cm
1	AGR	10.48	9.65	2.20	2.35	1.59	1.63	0.61	0.72	12.68	12.00	15.67	11.41
2	ENT	10.51	9.86	2.07	1.75	1.54	1.30	0.53	0.45	12.58	11.61	13.84	10.20
3	SWC	10.45	10.75	2.08	1.81	1.47	1.45	0.61	0.36	12.53	12.56	13.24	10.81
4	LPM	9.36	8.57	1.29	1.70	0.82	1.36	0.47	0.34	10.65	10.27	10.20	7.16
5	AV	10.47	9.41	2.02	1.74	1.35	1.36	0.67	0.38	12.49	11.15	15.06	10.20
6	AS	10.97	9.60	2.88	2.79	1.98	1.60	0.90	0.59	13.85	12.39	16.88	11.17
7	PLP	9.42	9.54	1.45	1.96	1.00	1.49	0.45	0.47	10.87	11.50	13.24	9.59
8	GPB	10.54	10.54	1.80	1.84	1.25	1.27	0.55	0.57	12.34	12.38	13.84	10.81
9	AGE	10.19	9.81	1.44	1.88	1.08	1.21	0.35	0.67	11.63	11.69	12.63	9.59
10	FS	9.32	9.02	1.80	1.73	1.10	1.15	0.70	0.58	11.12	10.75	14.45	10.20
11	FL	10.92	9.88	1.72	2.15	1.28	1.52	0.44	0.63	12.64	12.03	13.24	9.59
12	VS	9.55	9.40	1.88	2.50	1.42	1.72	0.46	0.78	11.43	11.90	15.67	9.59
13	UF	10.30	8.88	2.92	2.84	2.26	1.89	0.66	0.95	13.22	11.72	13.24	8.98
Minimum		9.32	8.57	1.29	1.70	0.82	1.15	0.35	0.34	10.65	10.27	10.20	7.16
Maximum		10.97	10.75	2.92	2.84	2.26	1.89	0.90	0.95	13.85	12.56	15.67	11.41
Mean		10.19	9.61	1.96	2.08	1.39	1.46	0.60	0.58	12.60	11.69	13.94	9.95

AGR- Agronomy, ENT- Entomology, SWC- Soil and Water Conservation, LPM- Livestock Production and Management, AV- AICRP(Vegetables), AS- AICRP(Soybean), PLP- Plant Pathology, GPB- Genetics and Plant Breeding, AGE- Agricultural Engineering, FS-Fruit Science, FL- Floriculture, VS- Vegetable Science, UF- Undisturbed Forest.

Table 5. Correlation coefficient between different soil properties.

Soil characteristics	Clay 0-20 cm	Clay 20-40 cm	BD 0-20 cm	BD 20-40 cm	pH 0-20 cm	pH 20-40 cm	CEC 0-20 cm	CEC 20-40 cm	OC 0-20 cm	OC 20-40 cm
N	0.262	0.207	0.984**	0.607*	0.545*	0.146	0.672**	0.120	0.612*	0.587*
P	0.212	0.041	0.468	-0.211	0.586*	0.513	0.358	0.341	0.540*	0.453
K	0.909**	0.826**	0.465	0.125	-0.607*	-0.537*	0.954**	0.839**	0.467	0.411
S	-0.037	0.014	0.820**	0.363	0.390	0.163	0.341	0.076	0.539*	0.325
PDA	0.004	0.297	0.116	-0.169	-0.707**	-0.624*	0.039	0.004	-0.204	0.532*
Ex-A	0.217	0.281	0.579*	0.079	-0.841**	-0.666**	0.491	0.319	-0.275	-0.370
Ex- Al^{3+}	0.302	0.419	0.566*	0.029	-0.907**	-0.645*	0.550*	0.417	-0.271	-0.464
Ex-H^+	-0.079	0.103	0.449	0.105	-0.415	-0.547*	0.186	0.169	-0.214	-0.212
TPA	0.116	0.447	0.374	-0.106	-0.874**	-0.391	0.281	0.202	-0.269	0.258
LR	-0.099	0.179	-0.259	0.221	-0.688**	-0.572*	-0.243	0.008	-0.212	-.007

*Significance at 5% level: 0.532, ** Significance at 1% level: 0.661
PDA= pH dependent acidity, Ex-A = Exchangeable Acidity, Ex-Al^{3+} =Exchangeable Aluminium, Ex- H=Exchangeable Hydrogen, TPA= Total Potential Acidity, LR=Lime Requirement.

et al. (2015). Exchangeable calcium and magnesium content in surface soils varied from 1.21 to 1.31 and 0.55 to 0.84 cmol kg^{-1} and in sub-surface soils 1.17 to 1.27 and 0.52 to 0.79 cmol kg^{-1}, with average values of 1.27, 1.23 and 0.67, 0.63 cmol kg^{-1}, respectively. Comparatively higher values of Ca and Mg were recorded in undisturbed forest soils. Possible reason of variation in Ca and Mg content is variation in organic matter content and mining by crops.

Components of soil acidity

The data pertaining to forms of soil acidity are presented in Table 4. Average values of pH-dependent acidity was 10.19 and 9.61 cmol kg^{-1} in surface soils and sub-surface soils, respectively, while it ranged from 9.32 to 10.97 and 8.57 to 10.75 cmol kg^{-1} in surface and sub-surface soils, respectively. Contribution of pH-dependent acidity toward total potential acidity was 80.9% and 82.2%, respectively in surface and sub-surface soils. Exchange acidity in surface and sub-surface soils ranged from 1.29 to 2.92 and 1.70 to 2.84 cmol kg^{-1} with an average value of 1.96 and 2.08 cmol kg^{-1}, respectively. Contribution of exchange acidity in total potential acidity was 15.5 and 17.8% for surface and sub-surface soils, respectively. Exchangeable H^+ and Al^{3+} contributed 30.6 and 70.9% and 27.9 and 70.2% in surface and sub-surface soils, respectively to exchange acidity. Reasonable exchange acidity in these soils may be due to presence of high exchangeable Al^{3+} (Longchari and Sharma 2022). Exchangeable Al^{3+} and H+ in surface soils varied from 0.82 to 2.26 and 0.35 to 0.90 cmol kg^{-1} and in sub-surface soils 1.15 to 1.89 and 0.34 to 0.95 cmol kg^{-1}, with a mean value of 1.39, 0.60 and 1.46, 0.58 cmol kg^{-1}, respectively. Total potential acidity of surface and sub-surface soils ranged from 10.65 to 13.85 and 10.27 to 12.56 cmol kg^{-1} with an average value of 12.60 and 11.69 cmol kg^{-1}, respectively. Higher quantum of total potential acidity was recorded in surface soils. Lime requirement of surface and sub-surface soils ranged from 10.20 to 15.67 and 7.16 to 11.41 t ha^{-1}, respectively with a mean value of 13.94 and 9.95 t ha^{-1} to increase the pH value to a desire level of 6.4. These results are confirmatory to the findings of Tsanglao *et al.* (2014), Konyak *et al.* (2020).

Correlation studies

Available N of surface soils appeared significant positive correlation with BD (r=0.984**), pH (r=0.545*), CEC (r=0.672**) and organic carbon (r=0.612*) and sub-surface soils had positive correlation with BD (r=0.607*) and organic carbon (r=0.587*) of the soils (Table 5). Available P of surface soils had significant positive correlation with pH (r=0.586*) and SOC (r=0.540*). Available potassium of both surface and sub-surface soils exhibited significant positive correlation with clay (r=0.909**, 0.826**) and CEC (r=0.954**, 839**) and significant negative with pH of the soils (r= -0.607*, -0.537*). In surface soils, available sulfur manifested significant positive correlation with BD (r=0.820**) and organic carbon (r=0.539*). Positive significant correlation between organic carbon and available nutrients revealed that organic matter is major source of available nutrients. The pH of the soils showed significant negative correlation with exchangeable H^+ (sub-surface soils r= -547*), exchangeable Al^{3+} (r= -0.907**, -0.645*), pH-dependent acidity (r= -0.707**, -0.624*), exchange acidity (r= -0.841**, -0.666**) and total potential acidity (surface soils r= -0.874**). While exchangeable Al^{3+} in surface soils had significant positive correlation with CEC (r=0.550*). Lime requirement of both depths had significant negative correlation with soil pH (r= -0.688**, -0.572*). Similar relationship among soil properties have also been reported by Longchari and Sharma (2022).

CONCLUSION

The results of the present investigation revealed that the soils of SASRD, Nagaland University research farm of was strongly to moderately acidic in reaction and low in CEC. The soils were high in OC, medium in available N, K and S and low in available P. Organic carbon and available nutrients were higher in the surface soils than in sub-surface soils. Higher values of pH-dependent acidity, exchangeable H, total potential acidity and lime requirement were recorded in surface soils, while higher values of exchange acidity and exchangeable Al were recognized in sub-surface soils. The soils of SASRD farm have major problem of acidity; the application of lime or other remedial measures are essential to improve soil fertility and better crop growth.

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