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SOIL ANALYSIS GIS-BASED FERTILITY ASSESSMENT AND MAPPING OF AGRICULTURAL RESEARCH STATION, PAKHRIBAS, DHANKUTA, NEPAL

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Abstract. Soil fertility evaluation has been considered as the most effective tool for sustainable planning of a particular region. This study was conducted to determine the soil fertility status of the Agricultural Research Station, Pakhribas, Dhankuta, Nepal. The total 60 soil samples were collected randomly at a depth of 0–20 cm by using the soil sampling auger. For identification of soil sampling points, a GPS device was used. The collected samples were analyzed for their texture, pH, OM, N, P_2O_5, K_2O, Ca, Mg, S, B, Fe, Zn, Cu and Mn status following standard methods in the laboratory of Soil Science Division, Khumaltar. The Arc-GIS 10.1 software was used for soil fertility maps preparation. The observed data revealed that soil was dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) colours, and single grained, granular and sub-angular blocky in structure. The sand, silt and clay content were 56.61±0.97%, 27.62±0.56% and 15.77±0.58%, respectively and categorized as loam, sandy loam and sandy clay loam in texture. The soil was very acidic in pH (4.66±0.07) and very low in available sulphur (0.53±0.11 mg/kg), available boron (0.24±0.07 mg·kg). The organic matter (1.34±0.07%), total nitrogen (0.09±0.003 mg·kg), available calcium (605.70±31.40 mg·kg), available magnesium (55.96±4.67 mg·kg) and available zinc (0.54±0.22 mg·kg) were low in status. Similarly, available potassium (115.98±9.19 mg·kg) and available copper (1.13±0.09 mg·kg) were medium in status. Furthermore, available manganese (36.31±2.82 mg·kg)

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was high, whereas available phosphorus (105.07±9.89 mg·kg) and available iron (55.80±8.89 mg·kg) were very high in status. The soil fertility management practice should be adopted based on the determined status in the field for the sustainable production of crops. The future research strategy should be built based on the soil fertility status of the research farm.

Keywords: ARS Pakhribas, fertility management, soil analysis, soil fertility maps, soil properties

INTRODUCTION

Soil is the most vital and precious natural resource that sustains life on the Earth. Soil fertility is the inherent capacity of the soil to supply nutrients to plants in adequate amounts and in suitable proportions (Panda 2010). Its proportion can be changed under the influence of regular natural and human induced factors. Therefore, it should be maintained where it is high, improved where it is low and developed where it is lacking. The soil fertility is inadequate for the crop production in the different research sites of Nepal Agricultural Research Council (NARC) (Khadka *et al*. 2016a, 2016b, 2016c, 2016d, 2017). This may show poor performance in the research activity for the respective sites.

The evaluation of soil fertility is perhaps the most basic decision-making tool in order to plan efficient land-use system (Havlin *et al*. 2010). Among the different methods of soil fertility evaluation, soil testing is a most basic one. It provides information regarding nutrient availability in soils which forms the basis for the fertilizer recommendations for optimizing crop yields. The texture, structure, colour, etc. are important soil physical parameters. Similarly, soil reaction (pH), organic matter, macro and micronutrients, etc. are also important soil chemical parameters. These parameters were determined after conducting an efficient analysis in the laboratory.

Soil properties vary spatially from a field to a larger regional scale and it is affected by soil forming factors which can be termed as intensive factors and extrinsic factors such as soil management practices, fertility status, crop rotation, etc. (Cambardella and Karlen 1999). Describing the spatial variability of soil fertility across a field has been difficult until new technologies such as Global Positioning Systems (GPS) and Geographic Information Systems (GIS) were introduced. The modern geospatial technologies such as GIS and GPS offer immense potential for soil and water resources development and management (Das 2004).

NARC was established to strengthen the agriculture sector in the country through agriculture research. Agricultural Research Station, Pakhribas, Dhankuta is an important wing among the research farms of NARC, in order to generate appropriate agriculture production technologies for eastern hills of Nepal. The research of different field crops (cereals, legumes, etc.) and vegetables (cabbage, cauliflower, tomato, radish, etc.) are being done from a longer period of time in the farm. Studies related to the soil fertility status of Agricultural Research Station, Pakhribas, Dhankuta are not done yet. Therefore, it is important to investigate the soil fertility status and provide valuable information relating agriculture research. Keeping these facts, the present study was initiated with the objective to assess the soil fertility status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal.

MATERIALS AND METHODS

Study area

The study was carried out at Agricultural Research Station, Pakhribas, Dhankuta, Nepal (Fig. 1). The research station is located at latitude 27.046033°N and longitude 87.292939°E as well as altitude 1,730 m above sea level. The area of farm situated in wide range of altitude low (Tallo-kholitar; 1,369 m above sea level) to high (Nagidada; 2,008 m above sea level). It covers a wide range of agro-climatic zones with annual rainfall of 1,600 mm, minimum temperatures ranging from 4.9–9.6ºC and maximum temperatures of 14.3–23ºC.

Soil sampling

Surface soil samples (0–20 cm depth) were collected from different sites of Agricultural Research Station, Pakhribas, Dhankuta, Nepal during January 2016. The total 60 soil samples were collected from the research farm by using the soil sampling auger (Fig. 2). The samples are taken only from the cultivated area of the farm mentioned as blocks in Figure 2. The other area shown in Figure 2 indicates the forest area, where cultivation is not yet provided. The exact locations of the samples were recorded using a handheld GPS receiver. The soil samples were taken from elevation ranged from 1,369 m above sea level to 2,008 m above sea level. The simple random sampling method was used to collect soil samples.

Laboratory analysis

The collected soil samples were analyzed at the laboratory of Soil Science Division, Khumaltar. The different soil parameters tested as well as methods adopted for the analysis are shown in Table 1.

Statistical analysis

Descriptive statistics (mean, range, standard deviation, standard error, coefficient of variation) of soil parameters were computed using the Minitab 17 package. Rating (very low, low, medium, high and very high) of determined values were based on Soil Science Division, Khumaltar. The coefficient of variation (CV) was also ranked for determination of nutrient variability according to the procedure of Aweto (1982) where, CV ≤ 25% = low variation, CV > 25 ≤ 50% = moderate variation, CV > 50% = high variation. ArcMap 10.1 with geostatistical analyst extension of ArcGIS software was used to prepare soil fertility maps while interpolation method employed was ordinary kriging with stable semi-variogram. Similarly, the nutrient index was also determined by the formula given by Ramamoorthy and Bajaj (1969):

$$\text{Nutrient index (N.I.)} = (N_L \times 1 + N_M \times 2 + N_H \times 3) / N_T$$

Where: N_L, N_M and N_H are the number of samples falling in low, medium and high classes of nutrient status, respectively, and N_T is the total number of samples analyzed for a given area. Similarly, interpretation was done as value given by Ramamoorthy and is shown in Table 2.

Fig. 1. Location map of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Table 1. Parameters and methods adopted for the laboratory analysis at soil science division, Khumaltar

S.N.	Parameters	Unit	Methods
1.	Physical		
	Soil texture (USDA)		Hydrometer (Bouyoucos 1962)
	Soil colour		Munsell colour chart
	Soil structure		Field-feel
2.	Chemical		
	Soil pH		Potentiometric 1:2 (Jackson 1973)
	Organic matter	%	Walkley and Black (1934)

S.N.	Parameters	Unit	Methods
	Total N	%	Kjeldahl (Bremner and Mulvaney 1982)
	Available P_2O_5	mg·kg	Olsen's (Olsen *et al*. 1954)
	Available K_2O	mg·kg	Ammonium acetate (Jackson 1973)
	Available Ca	mg·kg	EDTA Titration (El Mahi *et al*.1987)
	Available Mg	mg·kg	EDTA Titration (El Mahi *et.al*.1987)
	Available S	mg·kg	Turbidimetric (Verma *et al*. 1977)
	Available B	mg·kg	Hot water (Berger and Truog 1939)
	Available Fe	mg·kg	DTPA (Lindsay and Norvell 1978)
	Available Zn	mg·kg	DTPA (Lindsay and Norvell 1978)
	Available Cu	mg·kg	DTPA (Lindsay and Norvell 1978)
	Available Mn	mg·kg	DTPA (Lindsay and Norvell 1978)

Table 2. Rating chart of nutrient index

S.N.	Nutrient index	Value
1.	Low	< 1.67
2.	Medium	1.67–2.33
3.	High	> 2.33

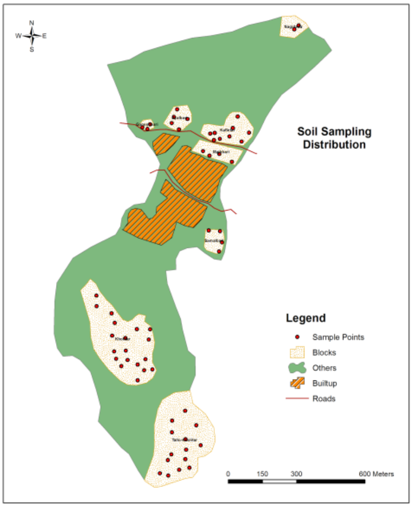

Fig. 2. Distribution of soil sample points during soil sampling

RESULTS AND DISCUSSION

The soil fertility status of the study area was assessed with respect to texture, colour, structure, pH, organic matter, primary nutrients, secondary nutrients and micronutrients such as B, Fe, Zn, Cu, and Mn, and the results obtained are presented and discussed in the following headings.

Soil texture

Soil texture is an important physical parameter influencing soil sustainability. It affects the infiltration and retention of water, soil aeration, absorption of nutrients, microbial activities, tillage and irrigation practices (Gupta 2004). The sand, silt and clay are the three components of soil texture. The sand content of soil samples ranged from 39 to 78.2% with a mean value of 56.61% and that of silt were 15.10 to 37.10% with a mean of 27.62%, while the range of clay were 6.70 to 26.80% with a mean of 15.77% (Table 3). The observed textural class symbolizes satisfactory condition for all the agricultural activity. The coefficients of variation between the soil samples were low for sand (13.21%) and silt (16.49%), while medium for clay (28.22%).

Table 3. Soil texture status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Descriptive statistics	Soil separates		
	Sand	Silt	Clay
		%	
Mean	56.61	27.62	15.77
SEM	0.97	0.59	0.58
SD	7.48	4.55	4.45
Minimum	39.00	15.10	6.70
Maximum	78.20	37.10	26.80
CV	13.21	16.49	28.22
Class	Loam, Sandy Loam, Sandy Clay Loam		

SEM – standard error of the mean; SD – standard deviation

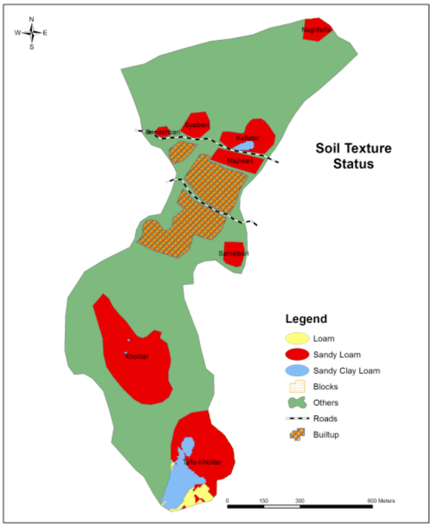

Fig. 3. Soil texture status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Soil colour

Soil colour is an indirect measure of other important characteristics such as water drainage, aeration, and organic matter content of soils (Foth 1990). Two soil colours – dark yellowish brown (10YR 4/4), and yellowish brown (10YR 5/6) – were observed in the majority of the area. The availability of yellowish colour indicates high content of hydrated form of iron in the soils.

Soil structure

Soil structure refers to the pattern of spatial arrangement of soil particles in a soil mass (Brady and Weil 2002). It is a vital physical property of soil. Three different types of structure such as single grained (high altitude), granular (medium altitude) and sub-angular blocky (lower altitude, i.e. Tallo-kholitar) were observed. The high altitude has a weak structure comparable to medium and lower altitude of the farm.

Table 4. Soil fertility status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Descriptive statistics	Soil fertility parameters				
	pH	OM	N	P_2O_5	K_2O
		%		mg·kg	
Mean	4.66	1.90	0.090	105.07	115.98
SEM	0.07	0.11	0.003	9.89	9.19
SD	0.51	0.83	0.020	76.59	71.20
Minimum	3.90	0.45	0.050	1.77	18.95
Maximum	6.31	5.98	0.210	322.33	430.43
CV %	10.92	43.86	25.670	72.89	61.39

SEM – standard error of the mean; SD – standard deviation

Soil pH

Soil pH is one of the most important determinants of soil fertility due to its influence on the solubility of metal ions, such as Al, Mn, Fe, Cu, Zn and Mo, its effect on the supply of nutrient cations and anions, and its influence on microbes present in soil and their activity (Brady and Weil 2002). High acidity is a major constraint in the different research farms of NARC (Khadka *et al.* 2016a, 2016c). The pH of soil varied from 3.90 to 6.31 with a mean value of 4.66 (Table 4). This indicates very acidic soil pH (Fig. 4). The soil pH showed low variability (10.92%) among the soil samples. The high acidity might be due to occurrence of profuse acidic parent materials like quartz, granite, rhyolite, etc. (Brady and Weil 2002). High acidity causes loss of basic cations, increases phototoxic elements such as Al and Mn; reduces beneficial microbial population, deteriorates soil structure, hence causes stress for growth and development of crops (Nduwumuremyi 2013). There is a need to reduce soil acidity in order to improve soil fertility for sustainable soil fertility management.

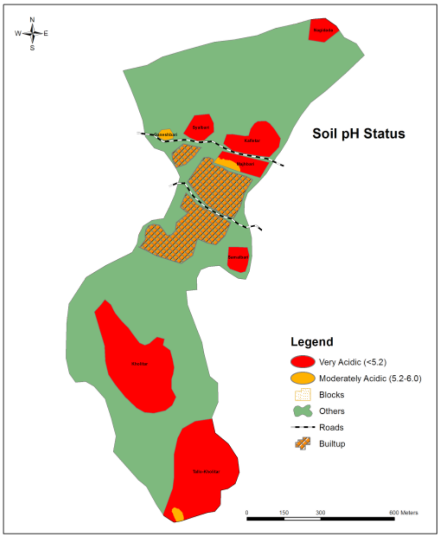

Fig. 4. Soil pH status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Organic matter

Organic matter is a key parameter for making soil alive, because it strengthens different physical, biological and chemical properties (Hoyle *et al*. 2011). The organic matter content varied from 0.45 to 5.98% with a mean value of 1.90% (Table 4). This shows low organic matter (Fig. 5; Table 7). Consistent result was also determined by Khadka *et al.* (2016b, 2016d, 2017) in the different research farms of NARC. The different agricultural practice like improper nutrient management, crop rotation, tillage practice, etc. might be the cause of low content of organic matter. Therefore, incorporation of different organic matter adding materials, adoption of suitable crop rotation and tillage practice is imperative for soil organic matter improvement. Organic matter showed moderate variability (43.46%) among the soil samples.

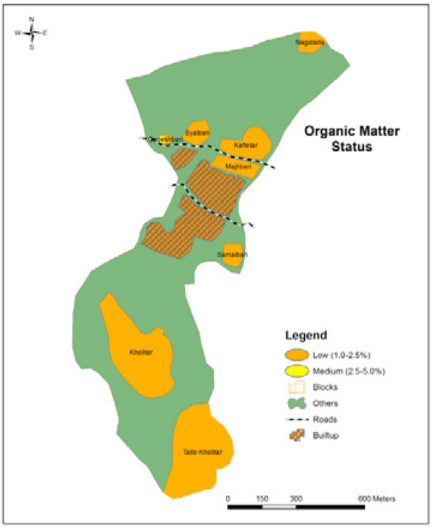

Fig. 5. Organic matter status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Total nitrogen

Nitrogen is the most imperative element for proper growth and development of plants (Leghari *et al*. 2016). It occupies a conspicuous place in the plant metabolism system. The total nitrogen content ranged from 0.05 to 0.21% with a mean value of 0.09% (Table 4). This indicates low content of total nitrogen (Fig. 6; Table 7). The low content of organic matter might be the cause of low total nitrogen. Those areas which have a low status should apply full dose (100%) of the recommended nitrogen dose, whereas 75% of the recommended dose in medium status area might be sufficient (Joshy and Deo 1976). Low variability (13.56%) in total nitrogen was observed among the sampled soils.

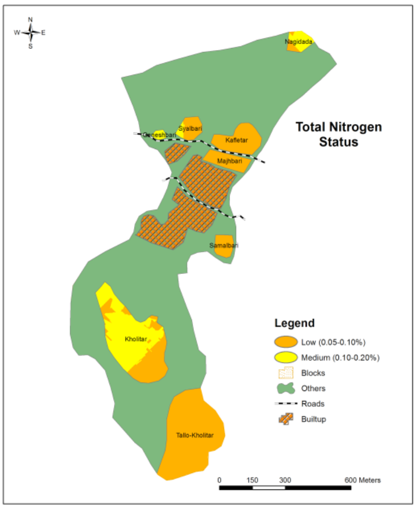

Fig. 6. Total nitrogen status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available phosphorus

Phosphorus has been called the “master key to agriculture” because low crop production is attributed mainly to the deficiency of phosphorus, except nitrogen, rather than the deficiency of other elements (Singh *et al*. 2016). The available phosphorus (P_2O_5) ranged from 1.77 to 322.33 mg·kg with a mean value of 105.07 mg·kg (Table 4). This showed very high status of available phosphorus (Fig. 7; Table 7). Phosphorus is very immobile in the soil, while continuous use of phosphate fertilizer without knowing their availability in the soil might be the cause of high phosphorus level in the high acidic as well as low organic matter containing soil. The phosphorus content is adequate; therefore, 40% of the recommended phosphorus dose might be sufficient (Joshi and Deo 1976). Available phosphorus showed high variability (72.89%) among the tested soil samples.

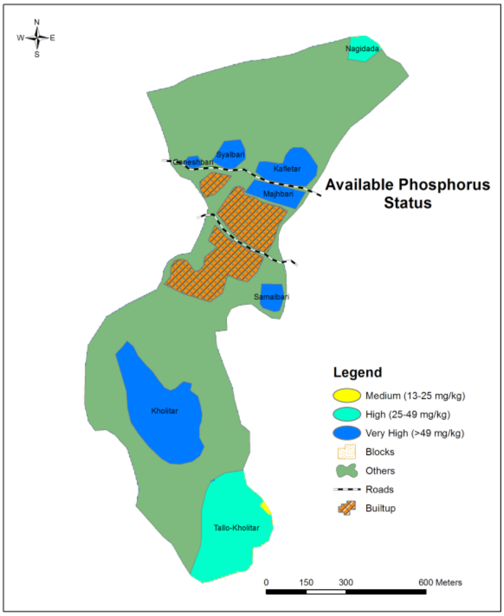

Fig. 7. Available phosphorus status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available potassium

Potassium exists in K^+ form and its function appears to be catalytic in nature (Singh *et al*. 2016). The available potassium (K_2O) content ranged from 18.95 to 430.43 mg·kg with a mean value of 115.9 mg·kg. This suggests a medium status of available potassium (Fig. 8; Table 7). The area having medium and high status, 60% and 40%, respectively of recommended potassium dose should be sufficient in the farm (Joshi and Deo 1976). High variability (61.39%) in available potassium was determined among the soil samples.

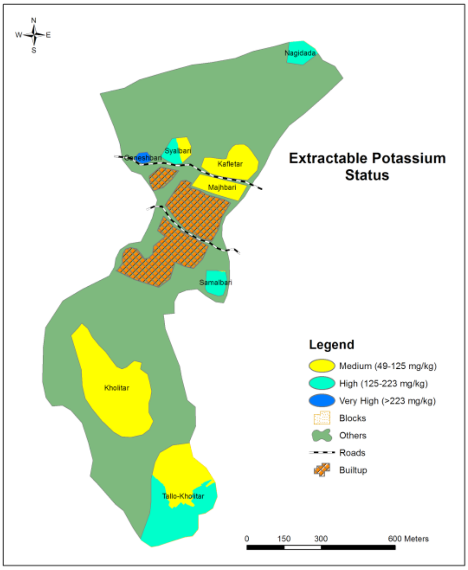

Fig. 8. Available potassium status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Table 5. Soil fertility status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Descriptive statistics	Soil fertility parameters			
	Ca	Mg	S	B
	mg·kg			
Mean	605.70	55.96	0.55	0.24
SEM	31.40	4.67	0.11	0.07
SD	242.90	36.15	0.87	0.51
Minimum	242.00	3.60	0.05	0.01
Maximum	1,452.00	166.80	5.11	2.85
CV %	40.11	64.60	158.76	212.31

SEM – standard error of the mean; SD – standard deviation

Available calcium

Calcium is an important secondary nutrient required for cell growth, division, elongation, and various essential biological functions (Hirschi 2004). The calcium content ranged from 242 to 1,452 mg·kg with a mean value of 605.70 mg·kg (Table 5). This indicates a low status of available calcium (Fig. 9; Table 7). Low status of available calcium might be due to occurrence of high soil acidity. Therefore, amelioration of soil acidity is a prerequisite solution for increasing calcium availability in the farm. Moderate variability (40.11%) in available calcium was observed among the soil samples.

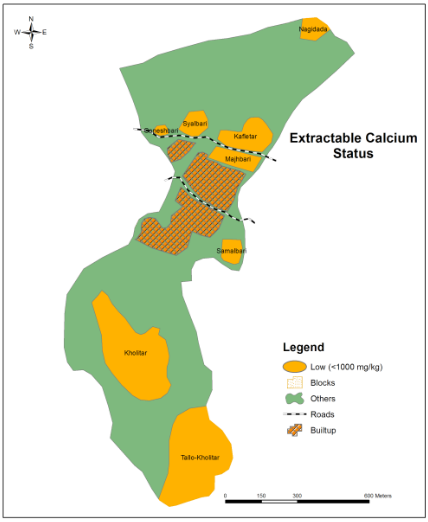

Fig. 9. Available calcium status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available magnesium

Magnesium is a water soluble cation and it is necessary for the chlorophyll pigment in green plants (Mahajan and Billore 2014). The magnesium content ranged from 0.60 to 166.80 mg·kg with a mean value of 55.96 mg·kg (Table 5). This reveals low content of available magnesium (Fig. 10; Table 7). Similar to calcium, high soil acidity might be the cause of low content of available magnesium. Therefore, amelioration of soil acidity is a prerequisite solution for increasing magnesium availability in the farm. The variation (64.60%) in the available magnesium of the observed samples was high.

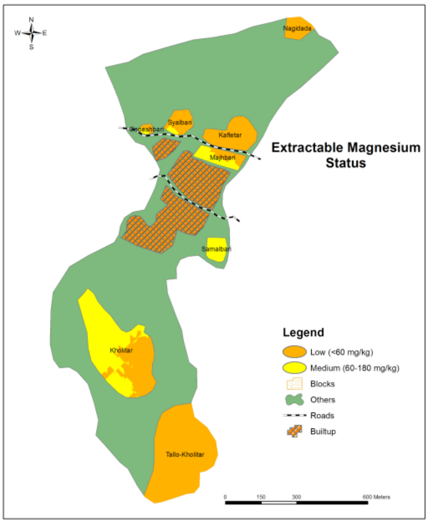

Fig. 10. Available magnesium status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available sulphur

Sulfur is the ninth richest element on the Earth's crust, plays a crucial role in the synthesis of chlorophyll, proteins, seeds oil content, as well as amino acids methionine and cysteine (Jamal *et al*. 2010). Sulphur is also a major limiting element in the different research farms of NARC (Khadka *et al*. 2016a, 2016b, 2016d, 2017). The available sulphur varied from 0.05 to 5.11 mg·kg with a mean value of 0.55 mg·kg (Table 5). In overall, available sulphur was very low in status (Fig. 11; Table 7). High acidity and low content of organic matter as well as continuous removal of sulphur by the crops due to intense cultivation without adding sulphur might be the cause of low amounts of sulphur in the soils. Therefore, amelioration of soil acidity and organic matter improvement is a prerequisite solution for increasing availability of sulphur. Available sulphur showed high variability (158.76%) in the soil samples.

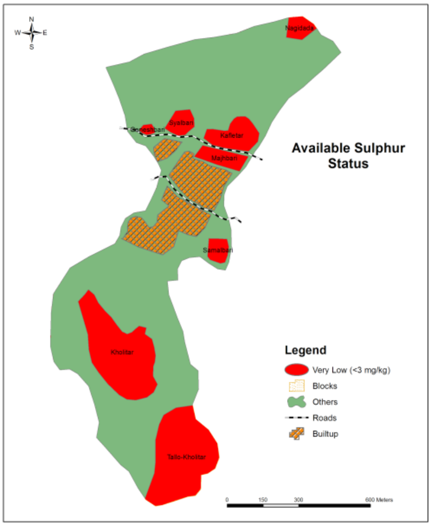

Fig. 11. Available sulphur status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available boron

Boron plays an important role in plants for sugar transport, cell wall synthesis, lignification, cell wall structure integrity, carbohydrate metabolism, ribonucleic acid (RNA) metabolism, respiration, indole acetic acid (IAA) metabolism, phenol metabolism, and as part of the cell membranes (Gupta *et al*. 2011). Boron is a major limiting element in the different research farms of NARC (Khadka *et al*. 2016a, 2016b, 2016d, 2017). The available boron content ranged from 0.01 to 2.85 mg·kg with a mean value of 0.24 mg·kg (Table 5). This indicates very low content of available boron (Fig. 12; Table 7). Low content of organic matter as well as continuous removal of boron by the crops due to intense cultivation without adding boron fertilizer might be the cause of low amounts of boron in the soils. Therefore, organic matter improvement and regular addition of boron fertilizer is imperative for reducing boron deficiency stress in the plants. High variability (212.31%) in available boron was observed among the soil samples.

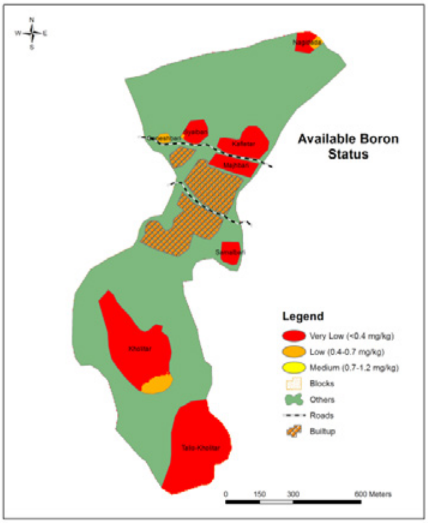

Fig. 12. Available boron status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available iron

Iron is an essential micronutrient for almost all living organisms because it plays a critical role in metabolic processes such as DNA synthesis, respiration, and photosynthesis (Rout and Sahoo 2015). Very high content of available iron is also another major limiting factor in the different research sites of NARC (Khadka *et al*. 2015, 2016a, 2016b, 2016c, 2016d, 2017). The available iron content varied from 13.80 to 169.20 mg·kg with a mean value of 65.90 mg·kg (Table 6). This shows a very high status of available iron (Fig. 13; Table 7). Highly acidic soil as well as high possibility of primary and secondary iron minerals such as hematite, olivine, siderite, goethite, magnetite, etc. might be the cause of huge content of available iron in the farm. High iron availability reduces the uptake of different plant essential nutrients such as P, K, Mn and Zn; thus shows deficiency stress of these elements in the plants (Fageria *et al*. 2008). Therefore, proper care should be taken for reducing deficiency stress of these antagonistic elements. The amelioration of soil acidity is a basic requirement for reducing high iron availability and reducing iron toxicity stress for plants. Available iron showed high variability (56.75%) among the soil samples.

Table 6. Soil fertility status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Descriptive statistics	Soil fertility parameters			
	Fe	Zn	Cu	Mn
	mg·kg			
Mean	65.90	0.89	1.13	36.31
SEM	4.83	0.09	0.09	2.82
SD	37.40	0.72	0.68	21.88
Minimum	13.80	0.12	0.26	0.68
Maximum	169.20	3.48	5.28	83.54
CV %	56.75	81.22	60.14	60.26

SEM – standard error of the mean; SD – standard deviation

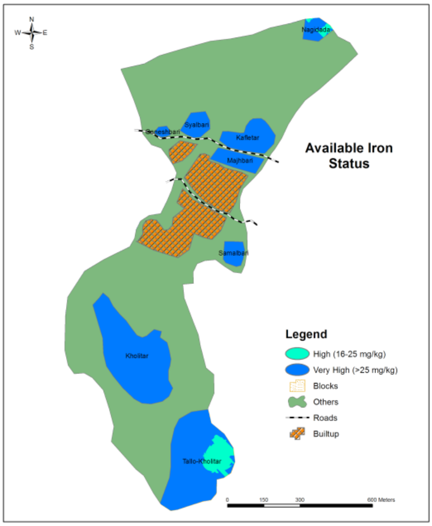

Fig. 13. Available iron status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available zinc

Zinc is essential in plants for several biochemical processes such as cytochrome and nucleotide synthesis, auxin metabolism, chlorophyll production, enzyme activation, and the maintenance of membrane integrity (Havlin *et al*. 2010). The available zinc content ranged from 0.12 to 3.48 mg·kg with a mean value of 0.89 mg·kg (Table 6). This indicates a low status of available zinc (Fig. 14; Table 7). Low organic matter and negative balance of zinc in the soil due to intense cultivation of crops without adequate application of zinc fertilizer might be the cause of low zinc status. Therefore, different organic and inorganic sources of zinc should be applied in the field regularly to reduce zinc deficiency stress in plants. The available zinc showed high variability (60.14%) among the soil samples.

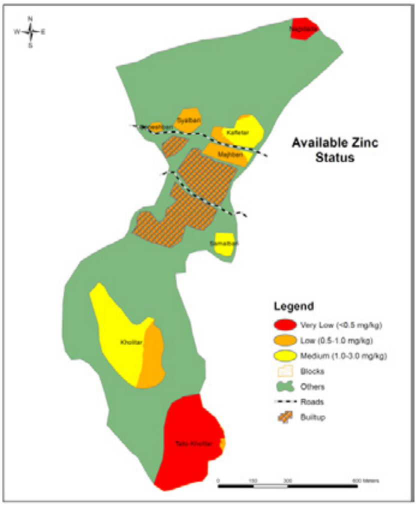

Fig. 14. Available zinc status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available copper

Copper is a transition metal found in soils either as the divalent (Cu^{2+}) or monovalent (Cu^{+}) cation, required for lignin synthesis and acts as a constituent of ascorbic acid, oxidase, phenolase and plastocyanin in plants (Havlin *et al.* 2010). The available copper content varied from 0.26 to 5.28 mg·kg with the mean value of 1.13 mg·kg (Table 6). This indicates medium status of available copper (Fig. 15; Table 7). High variability (60.14%) in available copper was recorded among the soil samples.

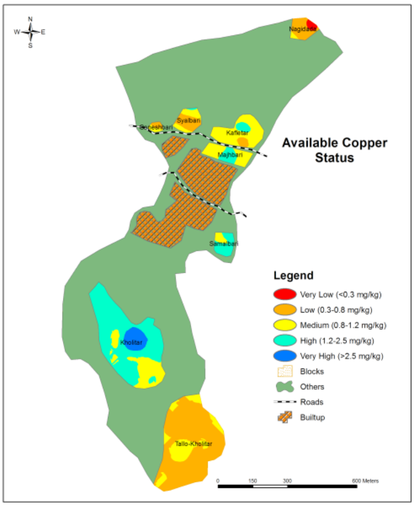

Fig. 15. Available copper status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Available manganese

Manganese is an important micronutrient, serves as a cofactor, activating numerous enzymes involved in the catalysis of oxidation–reduction, decarboxylation and hydrolytic reactions in plants (Mousavi *et al*. 2011). The available manganese content varied from 0.68 to 83.54 mg·kg with a mean value of 36.31 mg·kg (Table 6). This indicates a very high status of available manganese (Fig. 16; Table 7). High soil acidity might be the cause of high available manganese. The available manganese showed high variability (60.24%) among the studied soil samples.

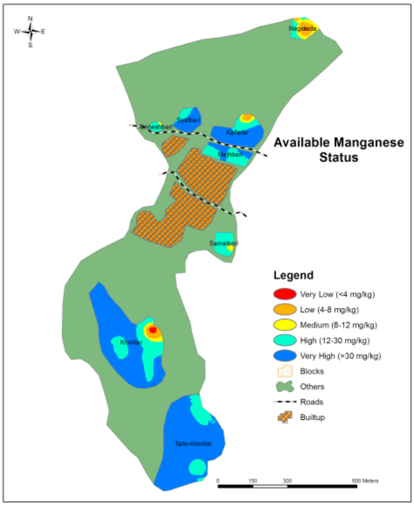

Fig. 16. Available manganese status of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

Table 7. Nutrient indices of studied parameters of Agricultural Research Station, Pakhribas, Dhankuta, Nepal

S.N.	Parameters	% distribution of samples					Nutrient index	Remarks
		Very low	Low	Medium	High	Very high		
1.	OM	10	75	13	2	-	1.17	low
2.	N	-	62	37	2	-	1.4	low
3.	P_2O_5	3	10	10	8	68	2.63	high
4.	K_2O	2	3	58	30	7	2.32	medium
5.	Ca	-	95	5	-	-	1.05	low
6.	Mg	-	158	8	-	-	1.33	low
7.	S	97	3	-	-	-	1.0	low
8.	B	82	10	3	2	3	1.13	low
9.	Fe	-	-	3	8	88	2.97	high
10.	Zn	42	18	38	2	-	1.42	low
11.	Cu	2	30	33	33	2	2.03	medium
12.	Mn	3	7	5	30	55	2.75	high

CONCLUSIONS

High acidity is a major limiting factor in the research farm. Amelioration of soil acidity is important to reduce a negative impact of soil acidity for the sustainable soil fertility management. Similarly, low organic matter is also another constraint for reducing soil sustainability. Adoption of organic matter adding practice such as organic manure and crop residue incorporation, reduced tillage are some prerequisites in the study area. Furthermore, fertilizer should be applied for each crop based on the determined status in the farm for the sustainable production. The plants may suffer from deficiency stress of low and toxicity stress of very high status of nutrients. The specific care should be taken for such types of nutrients. For enhancing research efficacy, the future research strategy should be built based on the soil fertility status.

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