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PLANT DIVERSITY AND PROFILE DISTRIBUTION OF SOME AVAILABLE MICRONUTRIENTS IN SELECTED SOILS OF KANO STATE, NIGERIA

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ABSTRACT

Availability of micronutrients in the right amount and proportion is vital for optimum nutrients utilization by diversity of plants. However, the current fertilizer recommendation for plants in Northern Nigeria is only for macronutrients and continuous application of one or two macronutrients may deplete the soil reserve of other nutrients; micronutrients inclusive, due to nutrients antagonism and consequently, reduce plant yield. For these reasons, this study was conducted to assess the profile distribution of zinc, copper, iron and manganese in selected soils of Kano state, Nigeria. Thirteen profile pits were sunk across thirteen (13) local government areas of Kano state. A total of (39) thirty nine composite samples were collected according to the pedogenic horizons at the different locations. In addition to the determination of other physical and chemical properties, available micronutrients; Cu, Fe, Zn and Mn were extracted with 0.1N HCl and the concentration of nutrients measured with atomic absorption spectrophotometer (AAS). Data obtained were subjected to Generalized Linear Model (GLM) procedure of Statistical Analysis Software (SAS) laid down in a randomized complete block design (RCBD). Significantly different means were then separated using Duncan multiple range test. Results obtained revealed that although Fe and Mn contents were adequate for crop production, Zn and Cu values ranges from 0.79 to 1.14 mg kg^{-1} and 0.76 to 1.11 mg kg^{-} respectively and were rated as inadequate in all the soils of the study area as such, supplementary application of these micronutrients could be beneficial for plant diversity development. Similarly, addition of organic residues as well as including Cu and Zn in fertilizer blends to be used in soils of the study area is necessary to improve plant diversity development. However, result of plant diversity is indicated with the Sahel Savanna having1,086 species, Sudan Savanna 1,116 species and 1,264 species in the Northern Guinea Savanna respectively.

Key words: Distribution, Kano state, Micronutrients, Plant diversity, Soil profile,

INTRODUCTION

Micronutrients are essential nutrient elements needed by plants in very small amounts. Although they are utilized in only minute quantities, plant cannot complete their life cycle without them (Brady and Weil, 2008). The availability of micronutrients in the right amounts and proportions play a vital role in the absorption of other nutrient elements, particularly nitrogen, phosphorus and potassium. Factors that affect the micronutrients distribution and availability in soils include; soil types, parent material, soil pH, clay content, amount of exchangeable bases, organic matter, and macro nutrients. Macias, (1973). Domchang *et al.* (2014) reported the availability of micronutrients, especially Zn and Cu, to be important for improved plant diversity development. Plant diversity constitute the vegetation, whose distribution is determined by corresponding variations in edaphic factors (Mahmudi and Hakimani, 2003), which constitute the nutrients distribution associated with sustainable plant diversity development.

Previously, there was dearth of information about micronutrients deficiencies in Nigerian soils. However, studies revealed that deficiencies of micronutrients have been diagnosed more frequently in recent times (Domchang *et al*., 2014;Oluwadare*et al*., 2013; Mustapha *et al*., 2011; Mustapha *et al*.,2010). These deficiencies could be attributed to continuous use of inorganic fertilizers (nitrogen, phosphorus, and potassium) and poor return of crop residues (Ibrahim and Abubakar, 2013). Similarly, Hassan and Ogbonnaya (2016); Mustapha and Loks (2005) reported that the relinquishment of the traditional extensive agricultural system, to a more scientific intensive one as well as the use of new high yielding crop varieties that are nutrient demanding have revealed micronutrient insufficiencies in Nigerian savanna. They added that, understanding the idea of balanced fertilization is an important factor that led to the realization of soil micro nutrient deficiencies by farmers and its importance in crop production. In addition, Oyinlola and Chude (2010) reported that the current fertilizer recommendation for crops in Northern Nigeria is only for macronutrients and opined that continuous application of one or two macronutrients may deplete the soil reserve of other nutrients; micronutrients inclusive due to nutrients antagonism and consequently, reduce plant diversity development.

If the problems of micronutrients deficiency must be addressed, then it has become very important to assess the micronutrients status of soils with a view of correcting their deficiencies. This is because, when even a single micro-nutrient becomes a limiting factor, water, fertilizer and other efforts made towards improving crop productivity may be fruitless, as crop yield is determined by the most limiting factor. Therefore, continuous assessment of micronutrients content of soils should be given utmost importance as this will help in agricultural planning as well as identifying areas where micronutrient fertilizers will be needed for higher crop yield. Similarly, this will aid in the planning of proper integrated soil fertility management (ISFM). For these reasons, this study was conducted to assess the profile distribution of zinc, copper, iron and manganese in some selected soils of Kano state.

MATERIALS AND METHODS

The Study Area

Kano state is located in northwestern Nigeria along longitude 8^0 $32^/$E and latitude 12^0 $3^/$N at an altitude of 476m (1562ft) above sea level. The average temperature of the state is 26.2^0C, the maximum temperature reaches 38-40^0 C in April and the coolest minimum reaches 13^0C in January. Kano receives an annual rainfall of 873mm annually. The mean recorded relative humidity average in a year is 31.1% to a maximum record of 68%. An average sunshine record of 6.0 hours/day to a maximum range of 9.8 hours/day has been recorded (Olofin, 1987).

Thirteen profile pits were sunk across thirteen (13) local government areas of Kano state including Gaya Local Government Area (Shagogo Village), Rimin Gado LGA (Butubutu), Makoda LGA (Shantake), Madobi LGA (Karofi), Kumbotso LGA (Riga Fada), Bagwai LGA (Maskaya), Danbatta LGA (Ajumawa), Bichi LGA (SantarAmarya), Wudil LGA (RegeKausani), Dawakin Kudu LGA (Tamburawa), Tofa LGA (GanjinDoka), Kiru LGA (Yako), Gabasawa LGA (Yadai Village)]. A total of (39) thirty nine composite samples were collected according to the pedogenic horizons at the different locations and labeled in polythene bags for ease of identification.

MATERIALS AND METHODS

The collected samples were air-dried in the laboratory until a constant weight was obtained. The samples were then ground using porcelain pestle and mortar and sieved through a 2 mm and 0.5 mm (for organic carbon and total N determinations) stainless steel sieve and analyzed at the Soil Science Laboratory of the Bayero University, Kano (BUK).

Particle size distribution was determined by the Bouyocous hydrometer method, Soil pH was measured in water in 1:2.5 using glass electrode pH meter as described by Jaiswal(2004).Organic carbon was determined by the dichromate wet oxidation method of Walkley and Black (1934). Available P was determined by Bray 1 method (Bray and Kurtz, 1945). Total and available nitrogen were determined by the Macro kjeldahl procedure as described by Jaiswal (2004). Effective cation exchange capacity was determined by summation method of IITA (1984).

Micronutrients; Cu, Fe, Zn and Mn were extracted with 0.1N HCl as described by Jaiswal (2003) and the concentration of nutrients measured with atomic absorption spectrophotometer (AAS). The vegetation was physically enumerated per unit square meter of the study area.

Data Analysis

Data obtained were subjected to Generalized Linear Model (GLM) procedure of Statistical Analysis Software

(SAS) laid down in a randomized complete block design (RCBD) with depth serving as the blocks and location as the treatments. Means were then separated using Duncan multiple range test.

RESULTS AND DISCUSSION

The results of some physical and chemical properties of the soils of the study area are presented on Tables 1 and 2. Results of the particle size distribution revealed that soils of Shantake, Regekasauni and Yadai are loamy sand in texture while Maskaya and Ajumawa fall in to the sandy clay loam textural class. However, soils of most of the study locations are sandy loam in texture (Table 1). This is in line with the reports of Sonneveld (2005); Jibrin *et al*. (2008); Adamu and Aliyu (2012) who reported that soils of northern Nigeria are mostly sandy with little silt and clay contents. Soil pH ranges from 5.4 in RegeKausani to 7.2 in Yadai (Table 2). This pH falls within the moderately acidic to neutral pH range based on the classification of Black (1965). Similar pH values were reported by Domchang *et al.* (2014); Mustapha *et al*. (2011); Voncir *et al*. (2008); Sonneveld (2005) for soils of the savanna and linked the result to the nature of parent materials, leaching of basic cations from the soil surface to lower depths and the frequent use of acid-forming fertilizers such as urea. Organic matter content of the study ranges from 3.19 to 8.78 mg/kg^{-1} and is considered low according to the classification of Esu (1991). Similar organic carbon contents were reported by Mustapha and Nanlee (2007); Mustapha *et al*. (2007) attributed the result to scanty vegetation and high decomposition rate typical of savanna climate.

Total and Available nitrogen contents of the areas are generally low. Available phosphorus (AVP) content generally falls within the low to medium range based on the classification of Esu (1991) except at Yako where AVP content of 27.2 mg/kg^{-1}was recorded and is considered high. Cation exchange capacity ranges from 5.9 to 10.6 cmol/kg^{-1} and falls within the low class (Black, 1965). Similar CEC values were reported by Raji *et al*. (2014); Domchang *et al.* (2014); Mustapha *et al*. (2011).A total of (1086) woody species of land cover were identified in the Sahel Savanna ecological zone. (1116) woody species enumerated in the Sudan Savanna whereas (1264) woody species were identified in the Northern Guinea savanna ecological zone respectively. Plant diversity pattern have shown several relationship with ecological studies over the last decades as supported by (Grace et al., 2007; Partel et al., 2010, Xiao et al, 2010). Numerous studies have reported diversity relationship patterns as positive, negative or no relationship (Hector et al., 2010; Ma et al., 2010).

Essiet in Tanko and Momale (2014) Stated that information was scanty on the deficiency of micro nutrients in the soils of Kano State, due to their predominantly sandy texture. Result from this research showed that all the micronutrients were at moderately to highly significant level which varies with the findings of Essiet in (2003) which stated that some micronutrients such as Boron, Zinc and Manganese, Iron and Copper are also deficient.

The results of some physical and chemical properties of the soils of the study area are presented on Table 1 and 2 respectively. Results of particle size distribution revealed that significant differences were observed on percentage Sand, Silt and Clay among the locations (Table 1). Results also showed dominance of Sand fraction on the particle size distribution. Soils of Shantake, Shagogo, Ajumawa and Yadai are Sandy loam in texture while Sandy Clay Loam was recorded as the dominant textural class in the remaining locations (Table 1). This is in line with the reports of Sonneveld (2005); Jibrin *et al*. (2008); Adamu and Aliyu (2012) who reported that soils of northern Nigeria are mostly sandy with little silt and clay contents. Soil pH varies significantly ($P < 0.05$) among the locations. Highest pH value of 6.9was recorded at Yadai while the lowest pH value of 5.8was recorded at RegeKausani (Table 2). However, these values fall within the neutral to moderately acidic pH range based on the classification of Black (1965).

Similar pH values were reported by Domchang *et al.* (2014); Mustapha *et al*. (2011); Voncir *et al*. (2008); Sonneveld (2005) for soils of the savanna and linked the result to the nature of parent materials, leaching of basic cations from the soil surface to lower depths and the frequent use of acid-forming fertilizers such as urea. With respect to Organic carbon content of the study areas, significant differences (P < 0.05) were observed. Highest organic carbon content of 5.99 gkg^{-1}was recorded at Ganjin Doka while the lowest value of 1.86 gkg^{-1}wasrecorded at Shantake. These values are considered low according to the classification of Esu (1991). Similar organic carbon contents were reported by Mustapha and Nanlee (2007); Mustapha *etal*. (2007) and attributed the result to scanty vegetation and high decomposition rate typical of savanna climate.

Total and Available nitrogen contents of the areas are generally low and varies significantly (P < 0.05) among the locations (Table 2). Similar to what was observed on available nitrogen, significant differences were observed on Available phosphorus (AVP) among the locations. Highest and lowest AVP values of 17.54 and 5.02 mgkg^{-1}were recorded at Yako and Rege Kausani respectively. These fall within the low to medium range based on the classification of Esu (1991).No significant differences were observed on soil Cation Exchange Capacity (CEC) among the locations. However, highest and lowest CEC of 9.23and 7.0 cmolkg^{-1}were recorded at Maskaya and Shantake respectively and fall within the low CEC class based on the classification of Black (1965). Similar CEC values were reported by Raji *et al*. (2014); Domchang *et al.* (2014); Mustapha *et al*. (2011).

Table 1: Species list and estimated number of woody plants encountered in the sampled areas of Kano state ecological zones.

Species scientific name	Sahel savanna	Sudan savanna	Northern guinea savanna
Andansoniadigitata	(11)	(18)	(17)
Acacia ataxacantha		(09)	
Acacia nilotica		(05)	(23)
Acacia Senegal		(08)	(15)
Aformosialaxiflora			(06)
Anacardiumoccidentale			(11)
Annonasenegalensis	(42)		(03)
Anogeisusleiocarpus		(05)	(16)
Acacia siebrena			(10)
Azadirachtaindica	(11)	(25)	(08)
Bauhinia rufesens		(20)	
Balsamidendronafricanum			(02)
Borassusaethiopum			(01)
Cassia arereh		(38)	
Calotropisprocera		(10)	
Catunaregannilotica	(10)		
Citrus medicus			(09)
Combretummicranthum		(70)	
Species scientific name	Sahel savanna	Sudan savanna	Northern guinea savanna
Combretumglutonism		(01)	
Commiphoraafricana		(192)	(39)
Dichrostachyscinerea			(10)
Diospyrosmespiliformis		(07)	(41)
Dalbergrasaxatalis			(03)
Eucalyptus sp.		(02)	
Euphorbia balsamifera		(30)	
Faidherbiaalbida	(14)	(06)	(12)
Ficusingus			(06)
Ficusglumosa			(05)
Ficusplatyphylla			(05)
Ficussychomorus			(15)
Guierrasenegalensis	(663)	(59)	
Jatrophacarcass	(171)	(303)	(156)

Khayasenegalensis		(06)	
Lawsoniainermis		(139)	(555)
Mangiferaindica		(10)	(16)
Moringaoleifera		(37)	(20)
Melina aborrea			(07)
Parkia biglobosa	(04)	(19)	(17)
Phylantusreticulatum	(05)		
Piliostigma sp.	(332)	(30)	(43)
Ptendra sp.		(04)	
ProsofisAfricana			(08)
Scelorcaryabirrea		(02)	
Sterculiasetigera			(05)
Tamarindusindica		(03)	(13)
Terminalia species			(05)
VitexDoniana		(04)	
Vitelleriaparadoxii	(01)		(08)
Zizziphusabyssinica		(04)	
Zizziphusspinachristii		(02)	(06)
Total	**1086**	**1116**	**1264**

Sahel savanna: Gabasawa, Makoda,and Dambatta
Sudan Savanna: Bichi, Wudil, Kumbotso, Tofa, RiminGado, Dawakin Kudu, Kumbotso, Madobi, Gaya and Bagwai
Northern Guinea Savanna: Kiru, Tudunwada, and Doguwa

Table 2: Soil Particles Size of the Study Areas.

Location	SAND	SILT	CLAY	TEXTURE
		(%)		
Shagogo	79.67ab	7.00abc	13.33b	Sandy Loam
Butubutu	66.33abc	7.67abc	26.00ab	Sandy Clay Loam
Shantake	81.33a	4.33c	15.33ab	Sandy Loam
Karofi	61.00c	15.00a	24.00ab	Sandy Clay Loam
Riga Fada	67.00abc	12.33abc	20.67ab	Sandy Clay Loam
Maskaya	60.33c	11.67abc	28.00a	Sandy Clay Loam
Ajumawa	80.00ab	4.67c	15.33ab	Sandy Loam
SantarAmarya	73.33abc	6.00bc	20.67ab	Sandy Clay Loam
RegeKausani	75.33abc	4.00c	20.67ab	Sandy clay Loam
Tamburawa	68.66abc	10.67abc	20.67ab	Sandy Clay Loam
GanjinDoka	63.33bc	12.00abc	24.67ab	Sandy Clay Loam
Yako	67.67abc	13.33ab	26.00ab	Sandy clay Loam
Yadai	76.00abc	8.00abc	16.00ab	Sandy Loam
SE±	5.163	2.551	3.840	

Table 3: Some Soil Chemical Properties of the Study Areas.

Location	pH (1:2.5 Soil: H_2O)	OC	TN	AVN	A VP (mg/kg)	Ca	Mg	K	Na	TEB	EA	CEC
			(g/kg)						(cmol/kg)			
Shagogo	6.5abc	2.53def	0.47ab	0.023ab	11.89bcd	3.76ab	1.63ab	0.21d	0.15c	5.75a	0.073a	8.07a
Butubutu	6.7ab	3.23cde	1.21a	0.060a	13.00bc	3.81ab	1.74ab	0.37abcd	0.27abc	6.19a	0.047abc	8.00a
Shantake	6.8ab	1.86f	0.16b	0.008b	12.82bc	3.29b	1.98ab	0.21d	0.15c	5.63a	0.047abc	7.00a
Karofi	6.7ab	2.39def	0.24b	0.012b	10.09bcd	3.74ab	2.34a	0.27bcd	0.19bc	6.35a	0.033bc	8.77a
Riga Fada	6.4bcd	2.13ef	0.18b	0.009b	8.67cde	4.21a	1.83ab	0.23cd	0.17c	6.35a	0.053ab	8.13a
Maskaya	6.0e	3.66cd	0.38ab	0.019ab	8.04de	3.05b	1.60ab	0.49abcd	0.35abc	5.50a	0.030bc	9.23a
Ajumawa	6.0e	3.32cde	0.34ab	0.017ab	9.58bcd	3.50ab	1.76ab	0.37abcd	0.27abc	5.90a	0.040bc	7.60a
SantarAmarya	5.5f	3.99bc	0.34ab	0.017ab	13.45b	3.46ab	1.60ab	0.44abcd	0.32abc	5.83a	0.036bc	7.57a
RegeKausani	5.8ef	3.46cde	0.43ab	0.022ab	5.02e	3.59ab	1.35ab	0.39abcd	0.322	5.62a	0.073a	8.43a
Tamburawa	6.0de	4.52bc	0.36ab	0.018ab	5.41e	3.44ab	1.11b	0.55abc	0.40ab	5.49a	0.050ab	8.27a
GanjinDoka	6.2cde	5.99a	0.52ab	0.025ab	12.93bc	3.48ab	1.37ab	0.67a	0.48a	6.00a	0.023bc	8.20a
Yako	6.6ab	5.06ab	0.44ab	0.021ab	17.54a	3.57ab	1.33ab	0.56ab	0.41ab	5.87a	0.033bc	8.87a
Yadai	6.9a	3.32cde	0.33ab	0.017ab	12.95bc	3.59ab	1.30ab	0.34bcd	0.27abc	5.49a	0.020c	7.33a
SE±	0.123	0.42	0.26	0.0013	1.318	0.262	0.320	0.093	0.067	0.539	0.009	0.741

Table 4: Mean distribution of Micronutrient across the study Areas

Location	Cu	Fe	Mn	Zn
	(mg/kg)			
Shagogo	0.83^{a}	9.67^{a}	4.41^{bc}	1.113^{a}
Butubutu	0.83^{a}	9.00^{a}	6.37^{abc}	0.937^{a}
Shantake	0.972^{a}	11.00^{a}	9.31^{ab}	1.042^{a}
Karofi	0.764^{a}	10.67^{a}	5.88^{abc}	0.903^{a}
Riga Fada	0.972^{a}	11.67^{a}	3.43^{c}	1.007^{a}
Maskaya	0.972^{a}	11.67^{a}	8.82^{ab}	1.146^{a}
Ajumawa	1.042^{a}	13.33^{a}	7.84^{abc}	0.833^{a}
SantarAmarya	1.042^{a}	7.67^{a}	7.84^{abc}	0.799^{a}
RegeKausani	0.972^{a}	8.00^{a}	6.37^{abc}	1.076^{a}
Tamburawa	0.764^{a}	10.67^{a}	4.90^{abc}	1.146^{a}
GanjinDoka	1.111^{a}	10.67^{a}	9.80^{a}	$0.9\ 03^{a}$
Yako	0.972^{a}	10.33^{a}	5.88^{abc}	$0\ .764^{a}$
Yadai	0.958^{a}	14.00^{a}	6.20^{abc}	0.937^{a}
SE ±	0.1867	3.020	1.515	0.1739

Means with the same letters on the same column are not significantly different

Table 1 is a plant diversity result obtained from the enumeration of the woody plants in the study area, where Sahel Savanna had a species number ranging from 11species to 663 species, while Sudan Savanna had a record of 01 species to 303 species and Northern Guinea Savanna recorded the range of01 species to 555 species across the study areas respectively.

Table 4 showed the result of micronutrients distribution across the study areas. Results obtained revealed that there were no significant difference on copper (Cu) content across the locations. However, Cu content ranges from 0.764 at Karofi and Tamburawa to 1.11 $mgkg^{-1}$ at Ganjin Doka. These values fall within the low range based the ratings of Esu (1991). Similar values were reported by Mustapha *et al*. (2010); Domchang *et al*. (2014). With respect to depth distribution, significant differences ($P< 0.05$) were observed (Table 5). Higher Cu concentration was observed at the lowest depth and was significantly different from the upper depths. The increased Cu content with depth may be linked to the leaching of exchangeable bases to lower depth. Domchang *et al*. (2014); Saddiq *et al.* (2008); Fagbami *et al*. (1985); Macias (1973) obtained similar results and linked Cu availability to increased clay and exchangeable bases.

Distribution of iron (Fe) contents across the study areas are presented in Table 4. Results revealed that highest iron content of 14.00 $mgkg^{-1}$ was recorded at Yadai followed by 13.33 $mgkg^{-1}$ at Ajumawa. Lowest Fe content of 7.67 $mgkg^{-1}$ was recorded at Santar Amarya but were not significantly different from each other. Iron contents of all the study locations are high based on the ratings of Esu (1991). Similar range of Fe contents were reported by Oyinlola and Chude (2010); Mustapha *et al*. (2010). The high Fe contents in soils of the study area may be due to the acid conditions of these s**o**ils. With respect to sampling depths, higher Fe contents were recorded at the soil surface (Table 5) and could be attributed to organic carbon content as well the slightly acid pH of the soil surface. Ivana *et al.* (2015) reported higher micronutrients content on the soil surface and attributed it to greater decomposition of soil organic matter and crop residues that contribute to micronutrient accumulation to the surface layers.

Manganese (Mn) status of soil of the study area is generally high based on the ratings of Esu (1991). Similarly, significant differences ($P < 0.05$) were observed on manganese content across the locations. Highest manganese content of 9 80 $mgkg^{-1}$ was recorded at Ganjin Doka followed by 8.82 $mgkg^{-1}$ at Maskaya. The lowest Mn content of 3.43 $mgkg^{-1}$ was recorded at Riga Fada (Table 3).

Based on sampling depths, significant differences were observed ($P < 0.05$) on Mn content (Table 5). Highest Mn content of 7.77 mg kg^{-1} was recorded at the lowest depth. The high Mn content observed across the study area may due to the acidic nature of the soils. Oyinlola and Chude (2010); Mustapha *et al.*(2010) obtained similar result and linked it to the slightly acidic nature of soils. Similarly, Sillanpaa (1982) reported that Mn tends to form hydroxides and chelates above pH 7.5 hence, reducing its availability. The increase in Mn content with depth was also reported by Mustapha *et al*. (2010).

No significant difference was observed on Zn content with respect to both locations and sampling depth (Table 3 and 4). However, the general Zn status of soils of the study area is low according to the rating of Esu (1991). Similar results were observed by Mustapha *et al.* (2011); Verma *et al.* (2005) while working with soil of Punjab.

Ma *et al.,* 2010; asserted that micro elements influences plant diversity in an ecosystem. Waide *et al.,* 1999; Cardinale *et al.,* 2000; Loreau *et al.,* 2001 and Kahmel *et al.,* 2015; supported that no management practice will aid in plant diversity without the role of micro elements for sustainable development. However, many studies have reported diversity relationship patterns as either positive, negative, or no relationship pattern (Hector *et al.,* 2010; Ma *et al.,* 2010).

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Table 5: Depth distribution of micronutrients along the soil profile micronutrient

Depth (cm)	Cu	Fe	Mn	Zn
			(mg/kg)	
0-20	0.897^{b}	12.00^{a}	6.10^{c}	0.934^{a}
20-60	0.914^{b}	8.62^{b}	6.34^{b}	1.086^{a}
60- 120	1.006^{a}	11.31^{a}	7.77^{a}	0.889^{a}
SE ±	0.0897	1.451	0.728	0.0836

Means with the same letters on the same column are not significantly different

CONCLUSION

This study clearly revealed that Zn and Cu are inadequate in all the soils of the study area and as such supplementary application of these micronutrients could be beneficial for plant diversity development

Recommendations

- Since continuous use of inorganic fertilizers, have been identified as the major source of nutrients imbalances in soils, caution must be taken to avoid indiscriminate use of macronutrients-borne fertilizers.
- Similarly, addition of organic residues, as well as including Cu and Zn in fertilizer blends to be used in soils of the study area, may improve crop plant production.
- If the problems of micronutrients deficiency is to be addressed, then continuous assessment of micronutrients content of soils must be given utmost importance, as this will help in the planning of proper integrated soil fertility management (ISFM).

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Conflict of Interest

There was no conflict of interest between the researchers

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