Spatial distribution of nutrient status of soils of Biswanath district , Assam, North East India

ABSTRACT

The present study was carried out to study the nutrient status of soils of Biswanath district of Assam in the year 2021. A total of 200 no of geo-reference surface (Upto 30 cm) soil samples were collected. The coefficient of variation (CV) was used for interpretation of variability of the indicators. Available phosphorous, available potassium DTPA-iron, DTPA-manganese, DTPA-zinc, and DTPA-copper were identified to be the most variable soil indicators (CV > 35%). Electrical conductivity, organic carbon, available nitrogen, cation exchange capacity, found as the moderately variable parameters (CV 15–35%). The least variation (CV < 15) was found in pH . The mean pH, electrical conductivity and organic carbon were 5.23, 0.54 ds/m and 0.81 per cent respectively. The cation exchange capacity of the soil varied from 4.40 to 11.60 cmol(p+)/kg with the mean value of 6.74cmol(p+) /kg. The available nitrogen, available potassium and available phosphorus 380.01kg /ha, 169.00 kg/ha and 38.01 kg/ha. The district's respective DTPA-Fe, DTPA-Cu, DTPA-Mn, and DTPA-Zn levels were found to be 83.34 mg/kg, 2.59 mg/kg, 22.25 mg/kg, and 0.79 mg/kg. The spatial distribution of each parameters were presented on the GIS platform for easy availability through IDW method of interpolation.

Key words : Geo-reference, Cation exchange capacity, GIS, IDW

INTRODUCTION

One of the key elements affecting crop production is soil fertility. The important factors that affect soil fertility and crop output includes the availability macro- and micronutrients. It is a natural occurrence that the amount of nutrients in soil to vary, with some being sufficient while others being insufficient. Assessment of a region's soil fertility level is crucial for ensuring sustained agricultural output. One of the most significant issues affecting agricultural productivity has been identified as the reduction in soil fertility caused by uneven fertilizer application. A thorough understanding of soil fertility is essential for detecting crop husbandry challenges and facilitating agro technology transfer programs. These goals require continued productivity. To identify the type and severity of their deficiencies/toxicities and to develop strategies for their correction in order to increase crop production, information on the status of fertility for different regions, is absolutely crucial. Therefore, research on the status of macro- and micronutrients and their interactions with soil characteristics is necessary to understand the inherent capacity of soil to supply these nutrients to plants. This will help us to achieve balanced nutrition to overcome soil fertility and improve soil fertility on a long-term basis. Assam's Upper Brahmaputra Valley Zones' soils showed deficiencies in nitrogen, phosphorus, potassium, zinc, and boron, with ranges of 6.0-16.0, 11.0-15.0, 14.0-17.0, 23-34, and 17-49%, respectively, according to an analysis of their soil fertility condition (Basumatary et al., 2014). However, there is a dearth of knowledge on the soil properties of the current research area. Keeping these factors in mind, a thorough investigation was conducted to determine the fertility status of the soils in the district and also an attempt was also made to prepare map of each soil chemical properties in GIS platform.

MATERIALS AND METHODS

Study area

The Biswanath district lies in between latitudes 26°35' to 27°00' and longitudes 92°50' to 93°50 with an area of 1,415 square kilometers. The district is bordered on the north by Arunachal Pradesh, on the south by the Brahmaputra, on the east by Lakhimpur district, and on the west by Sonitpur district. The District is situated between Arunachal Pradesh's himalayan mountains and the mighty Brahmaputra River. The area is part of Assam's hot, humid alluvial plain and in the North Bank Plain agro-climatic zone.

Collection of soil samples and analysis

200 geo-referenced surface soil samples (0–30 cm) were collected with the assistance of the global positioning system (GPS), for chemical analysis in the year 2021**.** The soil samples were crushed and sieved through a 2 mm sieve after being air dried. Basic soil parameters (pH, EC, and OC) and macronutrients (N, P, and K) were examined in the processed soil samples using established techniques (Jackson 1973, Bray and Kurtz, 1945 and neutral normal ammonium acetate, respectively). According to Lindsay and Norvell (1978), DTPA solution (0.005MDTPA+0.01 M$CaCl_2$ + 0.1M triethanolamine, pH 7.3) was used to extract the available Fe, Mn, Cu, and Zn from soil samples. An atomic absorption spectrophotometer was used for

determination of the micronutrients in the extract. The GIS software ArcGIS v.10.3 (ESRI Co, Redlands, USA) was used for spatial distribution of soil chemical properties. The spatial distribution of each results are presented on the GIS platform for easy availability through Inverse distance weighted (IDW) method of interpolation.

RESULTS AND DISCUSSION

The health and productivity of any soil depends on the concentration of soil fertility parameters like organic carbon, nitrogen, phosphorous and potassium and their effect on physical, chemical and biological properties of soil (Cao *et al.*, 2011). For sustainable agricultural production, maintenance of soil fertility and soil health is crucial (Prasad and Power, 1997) as it is related with chemical reactions in soil, availability of essential nutrients, their depletion and replenishment in soil.

Table 1. Descriptive statistical parameters of soil properties

Soil properties	Minimum	Maximum	Mean	S.D.	C.V. (%)
pH	4.10	6.80	5.23	0.62	4.10
Electrical conductivity (ds/m)	0.25	0.79	0.54	0.13	24.07
Organic carbon (%)	0.21	1.20	0.81	0.21	26.24
Available N (kg/ha)	200.74	566.78	380.01	90.29	23.76
Available P (Kg/ha)	7.02	56.94	26.86	12.75	47.49
Available K (kg/ha)	49.10	398.36	169.39	89.09	52.59
Cation exchange capacity (cmol(p+) /kg)	4.40	11.60	6.74	1.95	29.03
DTPA-Fe (mg/ kg)	33.64	168.33	83.34	32.56	39.08
DTPA-Cu (mg/ kg)	0.33	5.92	2.59	1.61	62.20
DTPA-Mn (mg/ kg)	3.28	68.68	22.25	12.17	54.70
DTPA-Zn (mg/ kg)	0.22	1.55	0.79	0.31	39.65

The pH was recorded from 4.10 to 6.80 with the mean value of 5.23 (Table 1), indicating soils were varied from strongly acidic to slightly acidic in nature, which was earlier reported by several workers (Basumatary *et al.*, 2012; Hazarika *et al.*, 2016). The annual rainfall and relative humidity which has been consistently washing down base elements from the soils, leading to development of acidic soil. Bhuyan *et al.* (2014) and Basumatary *et al.* (2019) also reported the acidic condition in soils of Assam. The soils of North-Eastern India were found to be acidic to neutral with low cation exchange capacity (Reza *et al.*, 2014). Increased acidity in Assam soil is basically due to high rainfall leading to depletion as well as deposition of some nutrients in soils (Nath, 2013). The least variation (CV < 15) was found in pH .The Fig. 1 provides the spatial distribution of pH in the District.

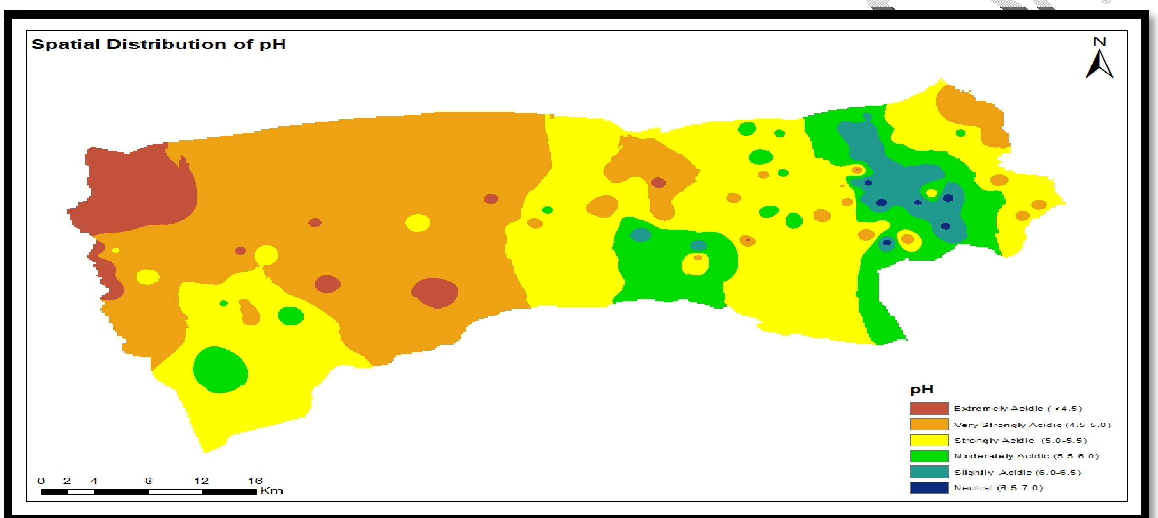

Fig. 1. Spatial distribution of pH in the soils of Biswanath District, Assam

Based on the limits given by Muhr *et al.* (1965), the electrical conductivity of the study area was found in the normal range (< 1.0 ds/m). The electrical conductivity ranged from 0.25 to 0.79 ds/m with the mean value of 0.54 ds/m (Table 1). The electrical conductivity can be an important soil fertility index for site specific management as it is highly corelated with crop yield (Li *et al.*, 2013). Low electrical conductivity of the study area might be due to inherent factors like soil minerals, climate, soil texture and leaching of soluble salts due to excessive rainfall (Roy and Landey, 1962; Singh and Mishra, 2012; Barooah *et al.*, 2020). The CV was found to be 24.07 per cent .The Fig. 2 provides the spatial distribution of electrical conductivity in the District.

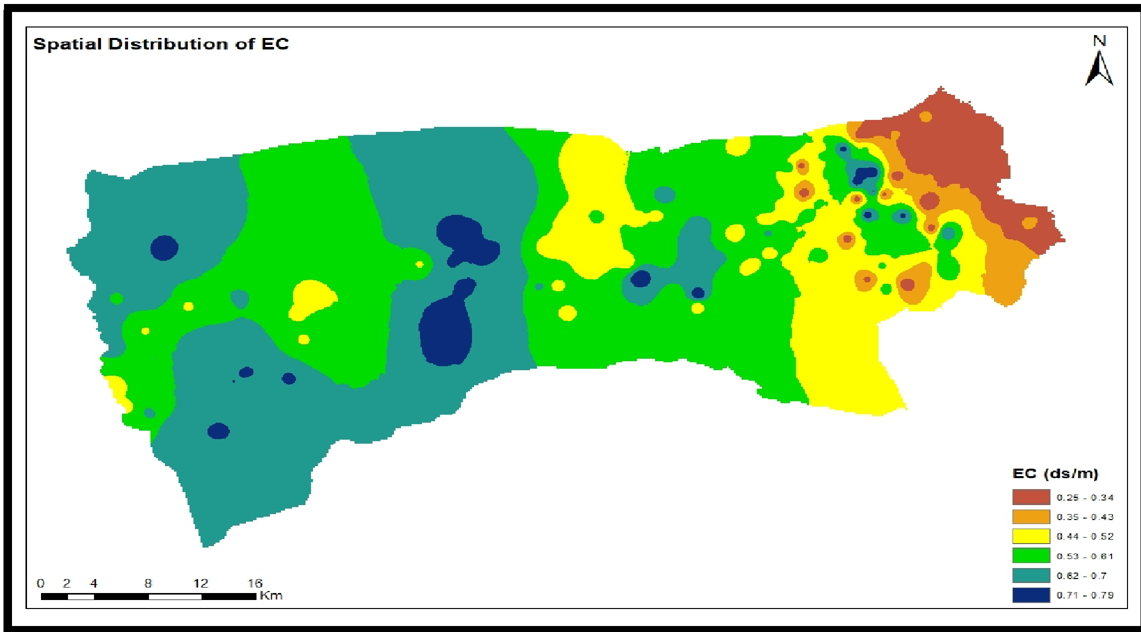

Fig. 2 . Spatial distribution of electrical conductivity (ds/m)in the soils of Biswanath District, Assam

The organic carbon content of the soil ranged from 0.21 to 1.20 per cent with an overall mean of 0.81 per cent (Table 1). The CV was recorded as 26.24 per cent .Good vegetative growth as well as addition of organic matter into the soil may increase the organic carbon content in the soil (Patil and Ananthnarayana, 1990). Availability of organic matter like vegetative growth and litter and their slow decomposition may lead to high level of organic matter which enriches nutrient and water retention capacity of soil and create favorable physical, chemical and biological environment (Kavitha and Sujatha, 2015). The Fig. 3 indicated the spatial distribution of organic carbon in the district.

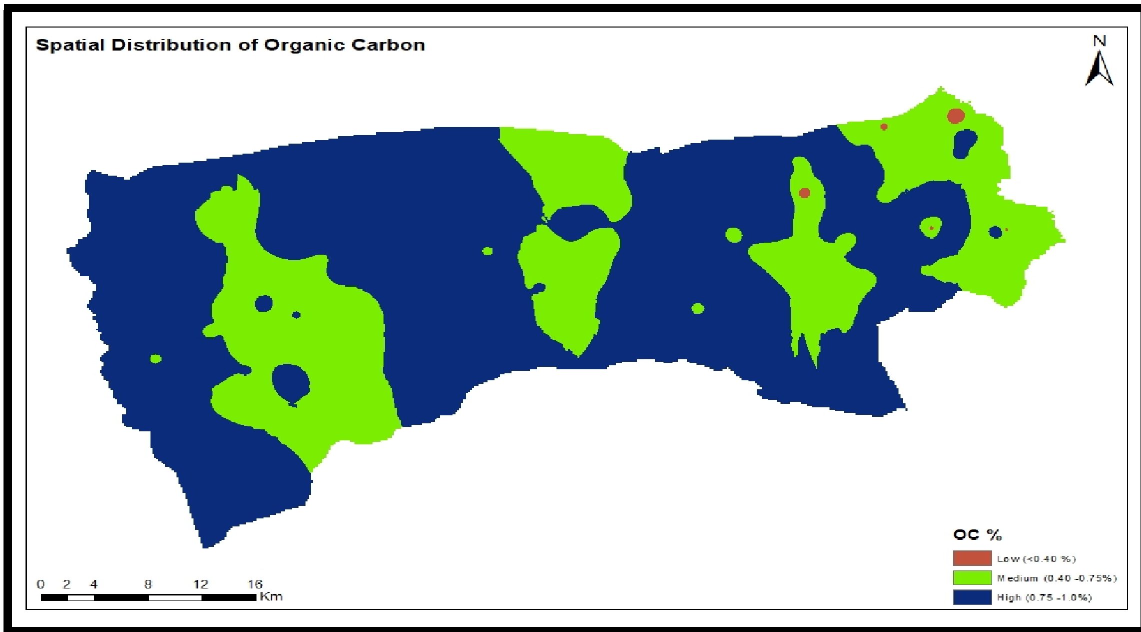

Fig. 3. Spatial distribution of organic carbon per cent in the soils of Biswanath District, Assam

The cation exchange capacity of the soil varied from 4.40 to 11.60 cmol(p+)/kg with the mean value of 6.74cmol(p+) /kg (Table 1),reflecting the dominance of low activity clay (Kaolinite) in these soils. The CV value was noted as 29.03 per cent. The Fig. 4 describes the spatial distribution cation exchange capacity of the District.

Fig. 4. Spatial distribution of cation exchange capacity (cmol(p+)/kg) in the soils of Biswanath District, Assam

The available nitrogen status in the soil ranged from 200.74 to 566.78 kg/ha having a mean value of 380.01kg /ha (Table 1). The CV was found to be 23.76 per cent. Similar result was also reported by Pandiaraj *et al.* (2017). Recommended organic manure and nitrogen fertilizer application in crops may build medium range of available soil nitrogen. Soil management, application of farm yard manure and fertilizer to previous crop may be related to variation in soil N content . Soil nitrogen dynamics regulation is mostly controlled by various agronomic practices (Zou *et al.*, 2018) and anthropogenic activity may also alter nitrogen cycling . The Fig. 5 describes the spatial distribution of nitrogen in the District.

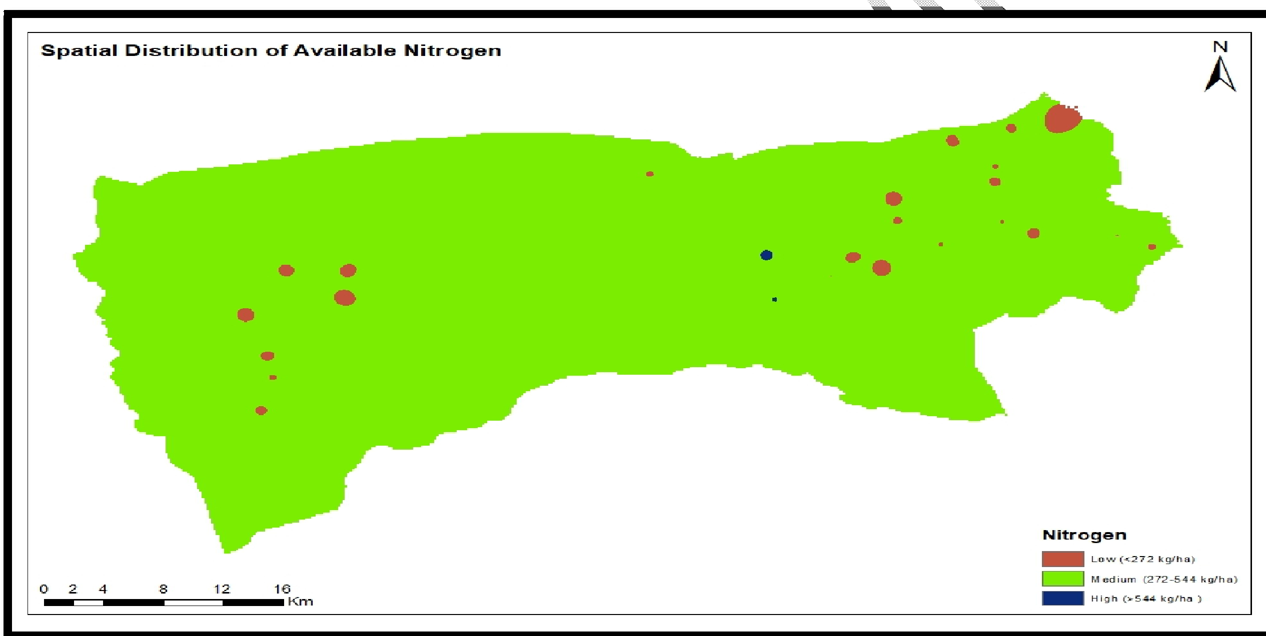

Fig. 5. Spatial distribution of available nitrogen (kg/ha) in the soils of Biswanath District, Assam

The available phosphorus content in soil ranged from 7.02 to 56.94 kg/ha with a mean of 38.01 kg/ha (Table 1). The CV was recorded as 47.49 per cent. Dutta *et al.* (2008) reported that in acid soils, there is a tendency of low soil phosphorus over time. The integrative effects of phosphorus transformation, availability and utilization caused by soil, rhizosphere and plant processes influence the availability of phosphorous in soil plant system (Shen *et al.*, 2011). The Fig. 6 describes the spatial distribution of phosphorous in the District.

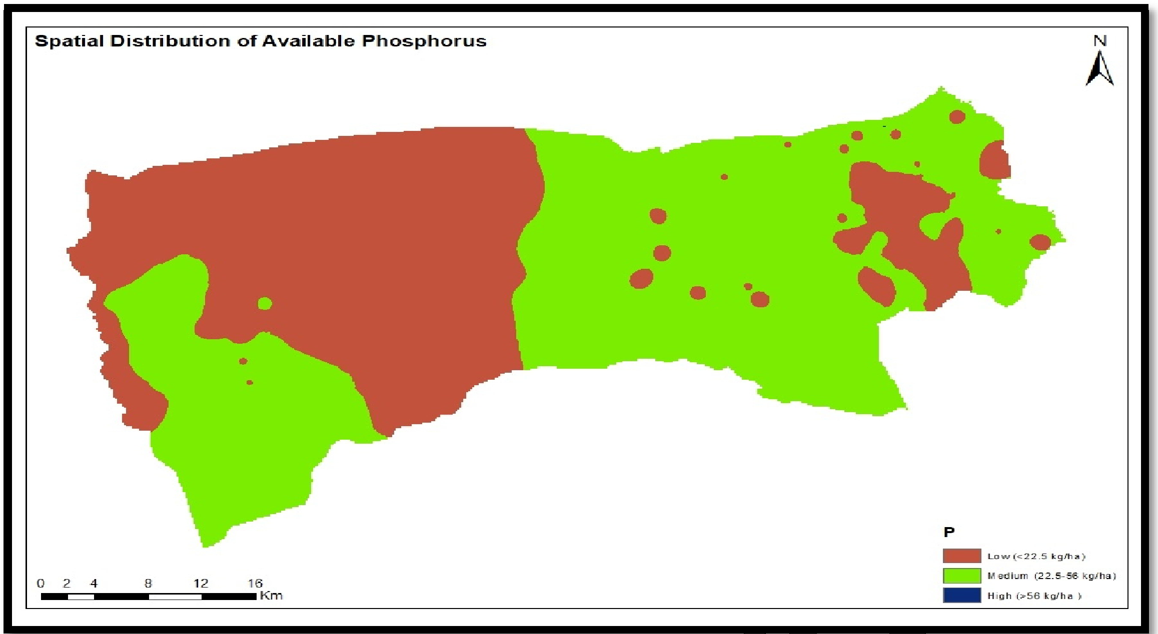

Fig. 6. Spatial distribution of available phosphorus (kg/ha) in the soils of Biswanath District, Assam

The available potassium in the soil varied from 49.10 to 398.36 kg/ha with a mean value of 169.00 kg/ha (Table 1). The CV was found to be 52.59 per cent. Low levels of potassium (Ghosh and Hasan, 1976) and medium range of potassium (Hasan and Tiwari, 2002) in Assam soil was reported earlier. Medium and low available potassium content of soil also depends on Kaolinite type of clay mineralogy (Pulakeshi *et al.*, 2012). The Fig. 7 describes the spatial distribution of potassium in the district.

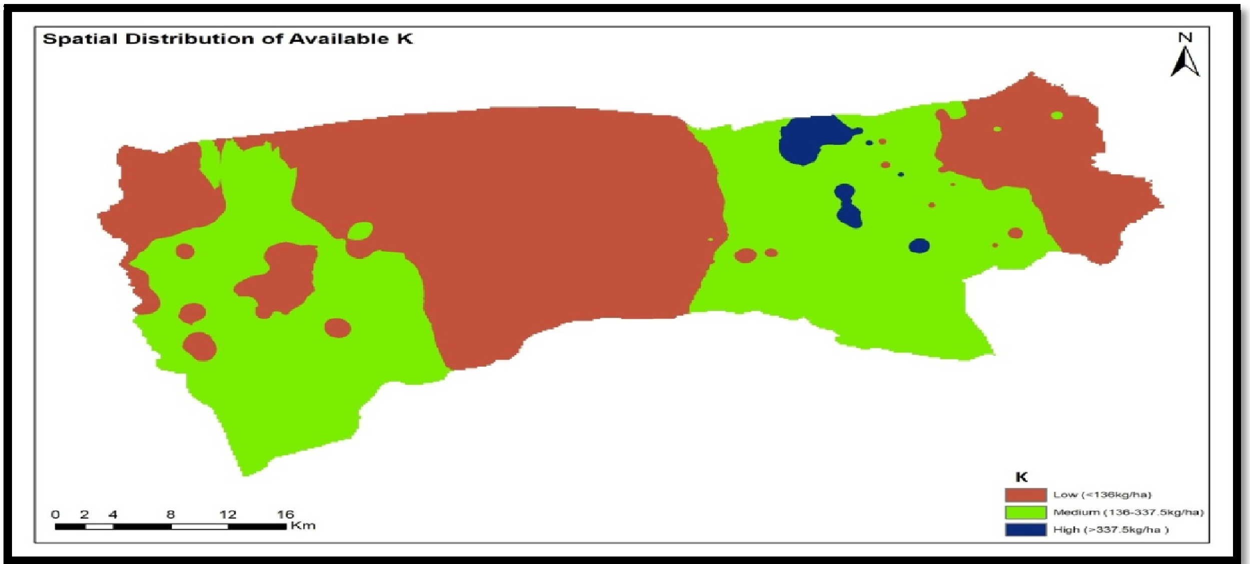

Fig. 7. Spatial distribution of available potassium (kg/ha) in the soils of Biswanath District, Assam

The DTPA-Fe content of the district ranged from 33.64 to 168.33 mg/kg with mean value of 83.34 mg/kg (Table 1). The CV was recorded as 39.08 per cent.The higher concentration of iron may be due to the higher organic carbon content because it acts as chelating agent. Iron reacts with certain organic molecules to form organo metallic complexes as chelates and the soluble chelates can increase the availability of the micronutrient and protect it from precipitation reactions. These chelates may also be synthesized by plant roots and released to the surrounding soil or may be present in soil humus. The increase in iron content with increase in soil organic carbon also reported by various workers (Behera and Shukla, 2013; Basumatary *et al.*, 2019). The Fig. 8 describes the spatial distribution of iron in the District.

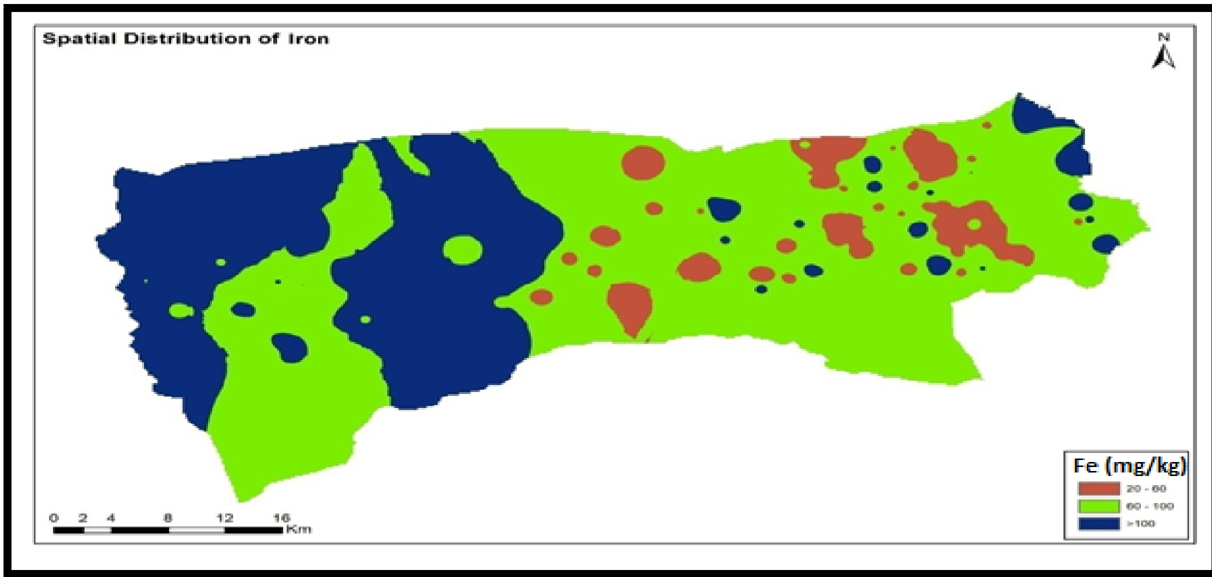

Fig. 8. Spatial distribution of DTPA-Fe (mg/kg) in the soils of Biswanath District, Assam

The DTPA-Cu content of the District ranged from 0.33 to 5.92 mg/kg with mean value of 2.59 mg/kg (Table 1). The CV value was found to be 62.20 per cent.The variability of copper is due to variation of pH of the soil. The Fig. 9 indicates the spatial distribution of copper in the District.

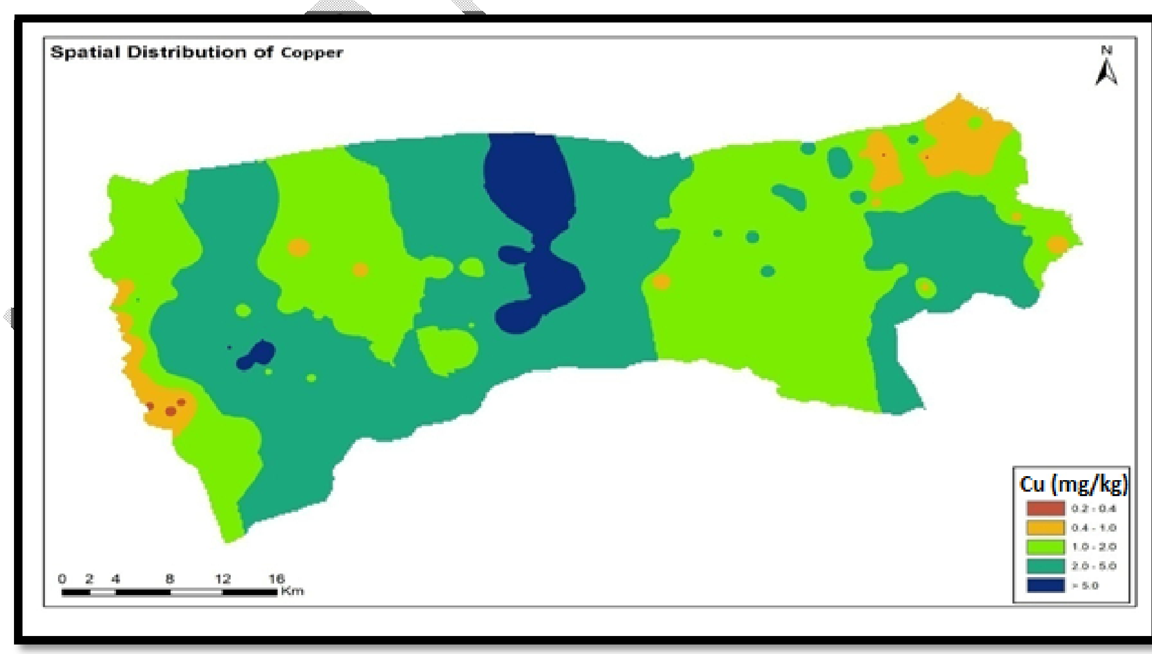

Fig. 9. Spatial distribution of DTPA-Cu (mg/kg) in the soils of Biswanath District, Assam

The DTPA-Mn content of the District ranged from 3.28 to 68.68 mg/kg with mean value of 22.25 mg/kg (Table 1). The CV was recorded as 54.70 per cent. This increase may also be due to the fact that decrease in soil pH increased the solubility of manganese with increase in organic matter and the exchange capacity of the soil leading to more retention of manganese. Similar, results were reported by Bhuyan *et al.* (2014) and Basumatary *et al.* (2014). The Fig. 10 indicates the spatial distribution of manganese in the District.

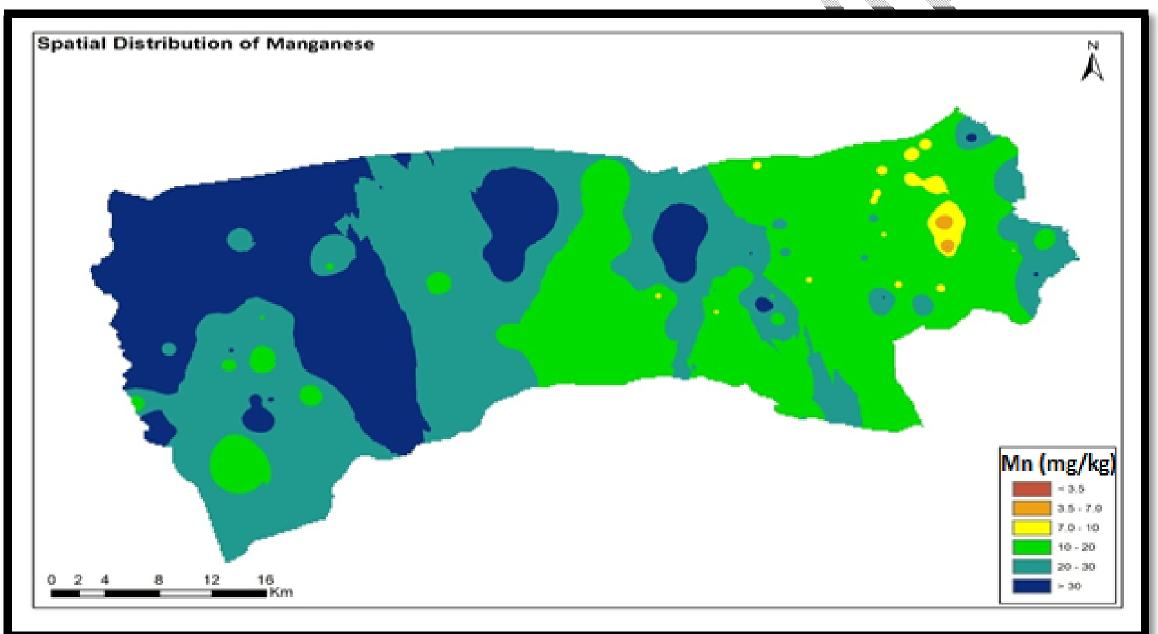

Fig. 10. Spatial distribution of DTPA-Mn (mg/kg) in the soils of Biswanath District, Assam

The DTPA- Zn content of the district ranged from 0.22 to 1.55 mg/kg with mean value of 0.79 mg/kg (Table 1).The CV was found to be 39.65 per cent. Distribution of zinc in any soil might be altered markedly by soil pH (Sims, 1986). The Fig. 11 describes the spatial distribution of zinc in the District.

Fig. 11. Spatial distribution of DTPA-Zn (mg/kg) in the soils of Biswanath District, Assam

CONCLUSION

According to the present study's findings, it may be concluded that the overall soils of Biswanath district were high in available nitrogen, medium in available potassium and low in available phosphorous. The DTPA-Fe ,DTPA-Cu and DTPA-Mn were high but the DTPA-Zn was medium. We have determined the nutritional status for each location using the geographical distribution of the nutrient map. This information can be useful in developing management practices for cultivated soils of the district.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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