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Assessment of Micronutrients Status and Soil Fertility Mapping in Arecanut and Black Pepper Growing Areas in Hulekal Hobli of Sirsi Talku, Uttara Kannada District

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ABSTRACT: The deficiency of nutrient elements and imbalanced nutrient management practices in agricultural soils is one of the reasons for low crop productivity and reduced nutritional quality of crop produce. The present study was carried out to assess the micronutrients status and to prepare soil fertility map of Arecanut and Black pepper growing areas at Hulekal hobli of Sirsi taluk. The Hulekal hobli has a total land holding of 42,398.31 ha, of which 25,395.92 ha (59.90%) is cultivatable land and 17,002.39 ha (40.10 %) is forest area. Altogether, 180 surface soil samples (0-20 cm) were collected from arecanut and black pepper cultivated areas of Hulekal hobli and were analyzed for micronutrients Fe, Mn, Zn and Cu and prepare the soil fertility maps through GIS using Kriging method. The results revealed that, The DTPA extractable micronutrients like iron (Fe), manganese (Mn), copper (Cu) found sufficient level (59.90 %). The DTPA extractable micronutrient zinc (Zn) was found deficient (38.60 %) in majority of the arecanut and black pepper garden fields. Therefore, the study reported that, the arecanut and black pepper growing area of Hulekal hobli were found high in iron (Fe), manganese (Mn) and copper (Cu) micronutrients with the exception of Zn, which found deficient in majority of study area. Hence there is a need of proper micronutrient management practices to achieve sustainable areaca and spice production.

Keywords: Arecanut and Black pepper, Micronutrients status, soil fertility mapping, Srisi taluk and GIS.

INTRODUCTION

Arecanut is one of the most profitable commercial plantation crops grown in hilly region of Karnataka with the extent of 0.5 m ha with the production of 1.08 MT (Anonymous DASD, 2021). Among different districts in Karnataka, Uttara Kannada is leading in productivity of arecanut with 2.5 t/ha. Within Uttara Kannada district, Sirsi taluk has highest area (8592 ha) but productivity is 2.55 t/ha only (DOH, 2021). Black pepper (*Piper nigrum* L.) (Family: Piperaceae) is major spices of commerce and trade in India since prehistoric period. Among the spices, Black pepper occupies a unique position and hence, called as the 'King of spices' and widely used for food flavouring.

Black pepper (*Piper nigrum* L.; Family: Piperaceae) is one of the most be important spices in Indian trade and commerce since the prehistoric period. Black pepper is known as the "King of Spices" because it occupies a distinctive position among spices. It is a climbing herbaceous perennial vine that is native to the humid tropical rain forests of Western Ghats of India. In Uttara Kannada district it is mainly grown as an associated mixed crop under the arecanut cropping system.

Traditional Arecanut and Black pepper cultivated soils are typically slightly acidic in nature, which may be attributed to parent material, drastic weathering under humid conditions and significant precipitation, all of which favour the process of laterization. (Ramachandra and Ganapathy 2007). As such crop like Arecanut and Black pepper is perennial in nature and their productivity is affected by many reasons, out of which soil nutrient imbalance is one of the important productivity constraints. Hartemink (2005) stated that large quantities of nutrients are immobilized in the above and below ground of perennial crops paving way for lesser efficiency. The serious concerns in arecanut cultivation are huge yield gap from location to location, sustained nutrient requirement and low nutrient use efficiency (Bhat and Sujatha 2009). The incidence of micronutrient deficiencies in soils increased markedly in recent years due to intensive cropping, loss of top soil by erosion, losses of micronutrients through leaching, decreased proportions of farm manure compared to chemical fertilizers. Micronutrients are important for maintaining soil health and also increasing productivity of crops (Bhanwaria *et al.*, 2011; Rattan *et al.,* 2009). The improper nutrient management has led to emergence of multi-nutrient deficiencies in the Indian soils (Sharma, 2008). So, there is a need for systematic and periodic assessment for nutrient deficiencies and sufficiency of micronutrients. So, the soil test data is the most accurate information on the availability of plants nutrients and to adjust the fertilizer recommendations to various crops. In this regard, a modern tool such as global positioning system will help to understand the status of soil fertility spatially. Geographic Information System (GIS) is a powerful tool which helps to integrate many type of spatial information such as agro-climatic zone, topography, land use, soil management to derive useful information (Adornado and Yoshida, 2008). Furthermore, GIS generated maps serve as a decision support tool for nutrient management (Iftikar *et al.*, 2010). A number studies on soil fertility mapping have been documented (Ravikumar *et al.,* 2010) but no study was made to map the soil fertility status of arecanut based growing of Hulekal hobli for micronutrients. Hence, an attempt was made to delineate the soil micronutrient status and to prepare the thematic maps of iron (Fe), manganese (Mn), copper (Cu) and Zinc (Zn) by using geographic information system (GIS) techniques with aim of providing balance nutrition through soil test based fertilizer recommendation, for sustainable crop production in the study area.

MATERIAL AND METHODS

A. Location of the study area

Hulekal hobli is located in Sirsi taluk of Uttara Kannada district, Karnataka, India (Fig. 1). It lies between 140 61′ to 140 83′ N latitude and 740 61′ to 740 85′ E longitude. The altitude of the study area is at 576 m above mean sea level which falls under hilly and coastal zone (9 and 10). The soils mostly belong to alfisols and oxisols, having slightly acidic, medium textured and well-drained soil conditions. Thus, the region provides optimum conditions for areaca and black pepper cultivation. Hulekal hobli has a total land holding of 42,398.31 ha, of which 24,214.75 ha (59.89%) is cultivatable land and 17,002.39 ha (40.10 %) is forest area.

B. Climate

Hulekal hobli experiences tropical monsoon climate and the weather is hot and humid throughout the year. It receives both South West and North West monsoons. The mean rainfall of the tract is 2500 mm with 103 rainy days in a year. Annually the day temperature averages about 25 hot days with temperature more than 35 °C and 124 warm days ranging 30-35 °C and remains below 35 °C during rest of the year for about 214 days (Agriculture Contingency Plan).

C. Soil sample collection

The demarcation of the study area was done at 1:50,000 scale toposheet and 1:5000 scale base map with Cartosat-1 PAN 2.5 mts and resource at-2 LISS-IV MX-merged satellite imagery was used for soil survey. The major arecanut and black pepper growing area was identified with the help of google earth pro and GIS software by marking the sample points on hobli map with masking of forest area overlaid village boundary was prepared and samples collection have planned such that samples are evenly distributed over study area Fig. 2. Based on the total arecanut and black pepper cultivated area. A total of 180 surface soil samples (0-20 cm) were collected from three locations and composite sample was prepared across the Hulekal hobli. Geographical location of each holding was recorded using GPS and basic information about the holdings like, age of plantation, variety, spacing, nutrient management practices and average dry nut yield obtained in q/ha.

D. Soil analysis

The collected soil samples were air- dried and sieved through 2 mm sieve and analysed for soil micronutrients namely, manganese, zinc, iron and copper were extracted using DTPA buffer solution (pH 7.3) in 1:2 soil: extractant ratio. The concentration in the extract was determined by AAS (Gerhardt; GB-20) using appropriate hallow cathode lamps (Lindsay and Norvell 1978) and their concentrations was expressed in ppm. The analytical results of each soil sample was categorised as deficient and sufficient based on the critical limits.

E. Generation of thematic soil fertility maps

Database on soil available nutrient status was generated in Microsoft by using QGIS software version 8.3. The point data was interpolated using ordinary krigging interpolation technique to prepare continuous map for different parameters using Smart Map plugin in QGIS. Semivariogram parameters like sill, nugget and range were derived by adjusting maximum distance and lags and then used models like linear, spherical, exponential or Gaussian to interpolate. Model which gave better R2 value and least RMSE was chosen for interpolation. Interpolated map was grouped into different categories based on standard nutrient ranges. By overlaying all the nutrient maps, management map was prepared.

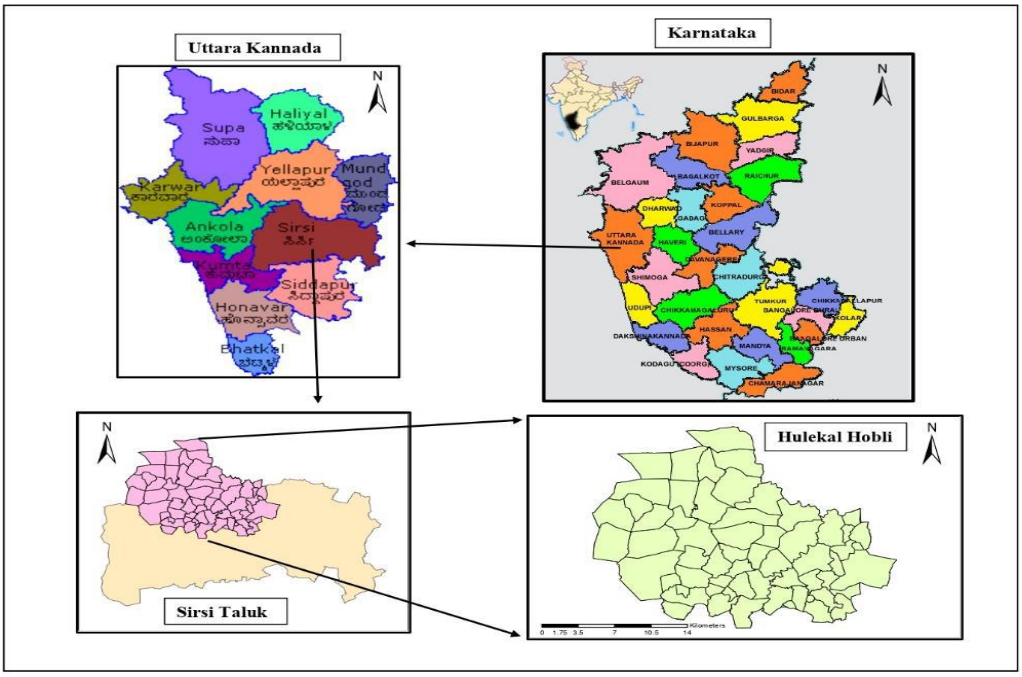

Fig. 1. Location map of Hulekal hobli.

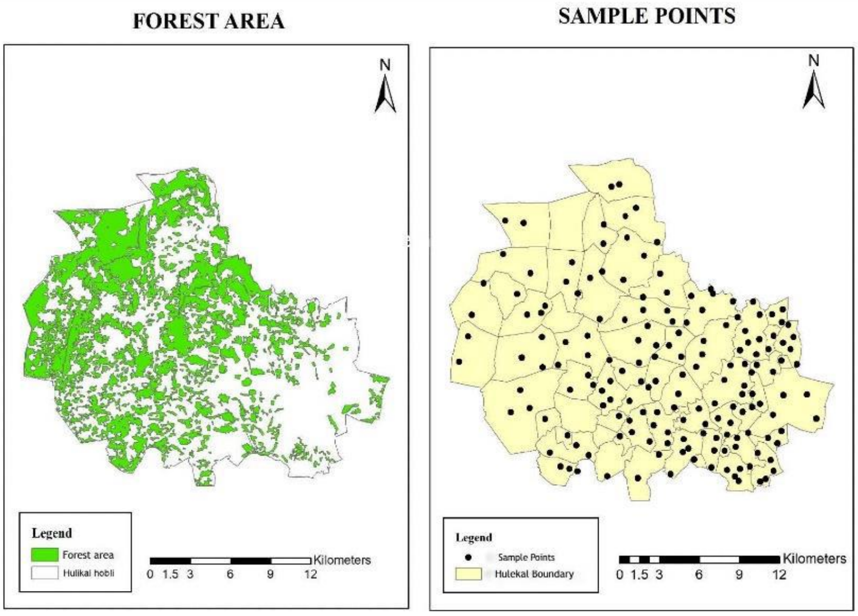

Fig. 2. Forest area and sample points of Hulekal hobli.

RESULTS AND DISCUSSION

DTPA extractable iron. The DTPA extractable Fe content in study area ranged from 12.36 to 61.22 ppm with a mean value of 32.21 ppm and SD of 9.82 ppm with CV of 30.5 per cent (Table 1). The spatial variability map of iron is shown in Fig. 3. The map shows about 25,395.92 ha (59.90 %) of the total arecanut and black pepper growing area in Hulekal hobli is under sufficient iron (>4.5 ppm) content and it is indicated as pink colour in map. The high content of iron in study area might be due to dominant of laterite soil and lower pH, which is formed under high temperature and high rainfall with alternate dry and wet conditions. Usually, laterite soil contains high sesquioxide which are rich in Fe and Al, the same result was found in arecanut garden (Mahesh Kumar *et al.*, 2015). This result was in line with the findings of Shivakumar (2013) and Prabhudev *et al.* (2017). It was observed that all soils recorded available iron above the critical limit.

DTPA extractable manganese (ppm). The DTPA extractable Mn content of study area ranged from 5.83 to 29.93 ppm with a mean value of 19.04 ppm and SD of 6.47 ppm with CV of 33.96 per cent (Table 1). According to the spatial variability map (Fig. 4) revealed that out of total arecanut and black pepper cultivated area in Hulekal hobli the maximum area of 25,395.92 ha (59.90 %) falls under sufficient amount of manganese (>4.5 ppm). It is indicated as light brown colour in map. High concentration of Mn in soil depends upon soil pH, organic matter and intensity of soil reduction. When organic matter content increase in the soil the population of soil microbes increases and very rapidly used up the soil oxygen and result in reduction of soil. As a result of soil reduction, the nutrient element like Mn^{4+} and Fe^{3+} reduce to Mn^{2+} and Fe^{2+} and increases their concentration in soil (Das, 2017). And also due to low soil pH coupled with the ferromanganese nature of the parent material, on which these soils developed might have contributed for sufficiency of extractable Mn.

DTPA extractable zinc (ppm). The DTPA extractable Zn content of study area ranged from 0.12 to 1.75 ppm with a mean value of 0.61 ppm and SD of 0.35 ppm with CV of 58.29 per cent (Table 1). Fig. 5 depicts the spatial distribution of Zn variability map. The largest area of 16,367.30 ha comes under zinc deficiency (0.6 ppm), accounting for 38.60 per cent of the total study area. In spatial variability map the Zn deficiency is indicated as yellow colour. The deficiency of Zn is showed in some parts of the study area it might be due to the study area soil were moderately to slightly acidic (5.5-6.5), which influence the decrease in Zn availability. The solubility of zinc is highly dependent on pH and decreases by 100 folds for each unit increase in soil pH. Availability of zinc decreases with the increase in soil pH, Zinc deficiencies occur usually in soils of pH 6.0 or more (Ganeshamurthy *et al*., 2019). It has been estimated that zinc deficiency is widespread and nearly 50 per cent of the Indian soils (Ganeshamurthy *et al*., 2019) and 74 per cent of Karnataka soils are deficit in zinc (Rattan *et al*., 1997). It was also opined that zinc is the most limiting nutrient to crop growth throughout the state of Karnataka (Anon., 1996).

DTPA extractable copper (ppm). The DTPA extractable copper content of study area ranged from 0.5 to 5.69 ppm with a mean value of 2.25 ppm and SD of 1.37 ppm with CV of 60.84 per cent (Table 1). To prepare the copper variability map (Fig. 6), soils were classified in to sufficient and deficient (Table 3). In Hulekal hobli the maximum area of 25,395.92 ha falls under sufficient amount of copper (> 0.2ppm) which is 59.90 per cent of total study area and it is indicated as yellow colour in map. The sufficient amount of copper status in study area is due to low pH, high organic carbon content and soil acidification may increase the bioavailability of copper (Cu) in soil, Cu was predominantly associated with Fe oxides and also soil organic matter (Santos *et al.*, 2013). The high content of copper may be attributed to the repeated sprays of Bordeaux mixture which contains copper sulphate ($CuSO_4$) and hydrated lime Ca $(OH)_2$ to combat Mahali or koleroga caused by phytophthora in arecanut black pepper field (Shilpashree *et al.*, 2011). It also might be due to the acidic nature of soil, with a decrease in soil pH and adsorption of copper to the permanent charges will decrease, which makes higher availability of copper.

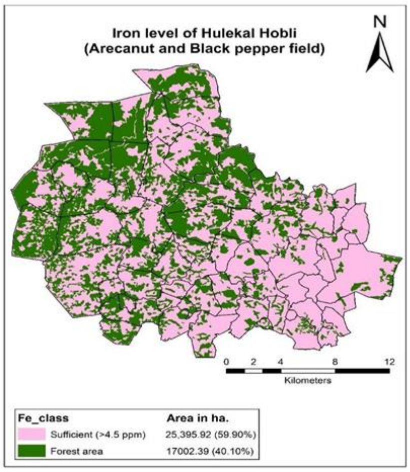

Fig. 3. Spatial variability map of Iron in Hulekal hobli soils.

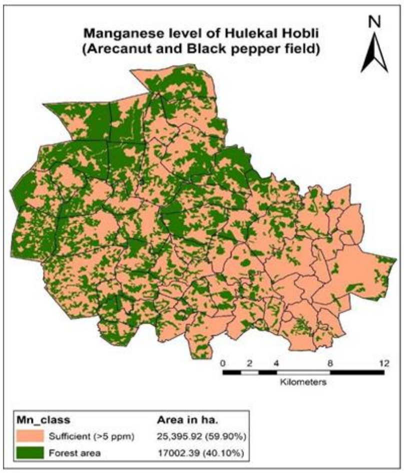

Fig. 4. Spatial variability map of Manganese in Hulekal Hobli soils.

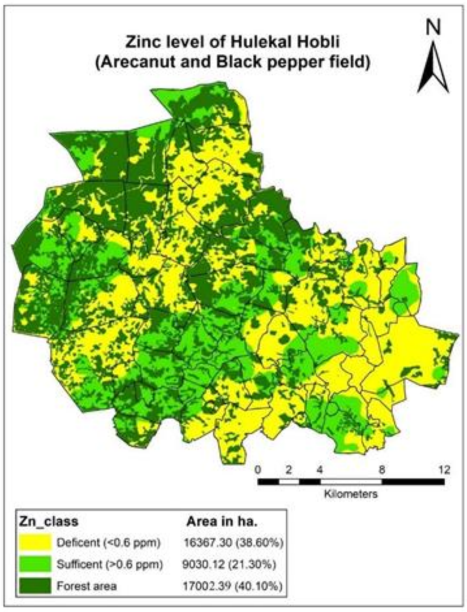

Fig. 5. Spatial variability map of Zinc in Hulekal hobli soils.

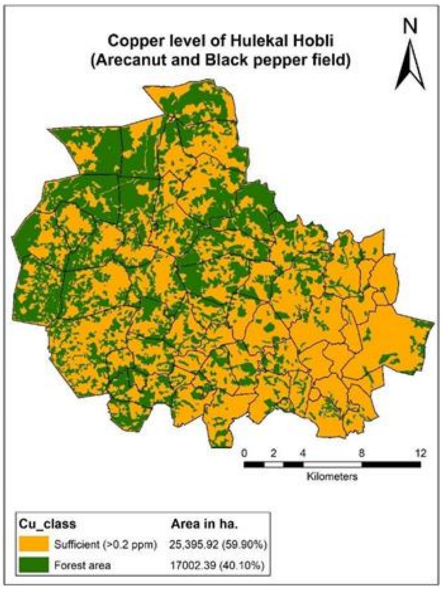

Fig. 6. Spatial variability map of Copper in Hulekal hobli soils.

Table 1: Descriptive statistical parameters of micronutrients status in soils of arecanut and black pepper cropping systems.

Soil Nutrients	Range	Mean	Standard deviation	Coefficient of variation (%)
Soil Nutrients	**Range**	**Mean**	**Standard deviation**	**Coefficient of variation**
DTPA extractable Fe (ppm)	12.36 – 61.22	32.21	9.82	30.50
DTPA extractable Mn (ppm)	5.83 – 29.93	19.04	6.47	33.96
DTPA extractable Zn (ppm)	0.12 – 1.75	0.60	0.35	58.29
DTPA extractable Cu (ppm)	0.50 – 5.69	2.25	1.37	60.84

Table 2: Extent of area under spatial distribution of DTPA extractable micronutrients (Fe, Mn, Zn and Cu) of arecanut and black pepper growing soil of Hulekal hobli.

DTPA Extractable iron (ppm)		
Class	**Area in (ha)**	**Cultivable area (%)**
Sufficient (> 4.5 ppm)	25,395.92	59.90
Defficient (< 4.5 ppm)	0.0	0.0
DTPA Extractable manganese (ppm)		
Sufficient (> 5 ppm)	25,395.92	59.90
Defficient (< 5 ppm)	0.0	0.0
DTPA Extractable zinc (ppm)		
Deficient (<0.6 ppm)	16367.30	38.60
Sufficient (>0.6)	9030.12	21.30
DTPA Extractable copper ppm)		
Sufficient (> 0.2 ppm)	25,395.92	59.90
Deficient (< 0.2 ppm)	0.0	0.0

Forest area	**17002.39 ha**	**40.10%**

NOTE:
Total area: 42,398 ha - (100 %)
Cultivable area: 25,395.92 ha - (59.90 %)

CONCLUSIONS

It was observed from present study that, the Arecanut and Black Pepper growing area soils of Hulekal hobli were found to be sufficient iron (Fe), manganese (Mn) and copper (Cu) micronutrients with the exception of Zn, which found deficient. Hence, there is a need of proper balanced micro nutrient application is require to achieve sustainable areaca and spice production in the study area.

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