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Micronutrient availability among different cropping systems of Bilagi and Bagalkot Taluka

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Abstract
A survey based study was conducted to assess the soil fertility status of black soils of different cropping systems. A Survey was carried out in 147 fields of Bilagi and Mudhol taluka during 2016-17 under Cereals, Maize/Groundnut-Onion and Sugarcane cropping systems. The surface soil samples (0-15 cm) were collected and analysed for soil pH, $CaCO_3$, SOC and DTPA extractable micronutrient contents. Micronutrient availability significantly varied among different cropping systems and they were found in the order Mn > Fe > Cu > Zn. Among different cropping systems, the availability of DTPA-micronutrients were found significantly different in the order of sugarcane=maize/ groundnut-onion> jowar cropping systems.

Keywords: Micronutrients, black soils, sugarcane, jowar, irrigated area, free $CaCO_3$

Introduction
Soil is one of the most important natural resource without which terrestrial life cannot sustain. Soil serves as media for plant growth to feed humans and animals and hence, it is one of the major sources of livelihood to most of the human population on earth. Soil contains nutrients (macro and micronutrients) and it also supports to the plant growth by providing all the essential needs. Black soils are the most dominant soils of northern dry zone having semi-arid climatic conditions. The major limiting factor of these black soils is pH and soil salinity (Rekha *et al.*, 2018; Shreekanth *et al.*, 2018) [16, 21]. Soils of arid and semi-arid areas also exhibit chemical soil degradation in the form of salinization and/ or sodification. Soil texture plays an important role in soil salinity (Nagaraja *et al.*, 2016) [7, 11, 20].
Soil micronutrient deficiency can influence both yield and quality of the crop and correcting its deficiency is important to maintain soil fertility and achieve genetic yield potential of crops. Deficiency of micronutrient has become major constraint to the productivity, stability and sustainability of crops in many Indian soils and may deteriorate further due to loss of soil organic matter induced by global warming.
The deficiency problem in arid and semi arid region were prominent in soils with high pH as determined by the soil pH, free $CaCO_3$ content and low organic matter content soils. Micronutrient management varies with crops, types of soil, severity of deficiency, method of application, time and frequency of application (Punithraj *et al.*, 2012; Shivakumar and Nagaraja, 2016) [7, 11, 20]. The large variation in rate of micronutrient application appears to be the key factor in determining their availability in soils depending on the crops sensitivity, soil types and availability status, soil environment, source and their residual effects and method of application.

Material and Methods
Bagalkot district is situated at 16^1 12^0 N and 75.45^0 E in northern Karnataka with a total geographical area of around 6.5 lakh ha. The Bagalkot district falls under semiarid region with mean annual rainfall of 517.3mm and mean temp of 32.6 ^{o}C. These criteria were overlaid on 2.25 × 2.25 Sq.km grid maps of Bilagi and Bagalkot talukas. The Bilagi and Bagalkot talukas of natural resource maps, toposheets of Survey of India (1:50,000) and Soil maps of NBSS and LUP (at 1:1,00,000 scale) prepared by KSRSAC for were used.

Collection of soil samples

The toposheets of Bilagi and Bagalkot (1;50,000 scale) with the existing grids of 4.5 x 4.5 km^2 (20.25 Sqkm) were split into to 4 equal units of 2.25 x 2.25 km^2 grids having an area of 5.06 Sq km. Each of these grids were considered as a sampling unit and marked for soil sampling. In each unit soil colour, irrigation water sources, dominant cropping systems along with the details on crop were recorded. The exact soil sampling locations were recorded using GPS meter (eTrex Garmin model 20). The actual locations from each point 3 surface soil samples (0-15 cm) were collected as replications and made into one representative composite sample of that site. Representative Soil samples for each study unit was collected and brought to laboratory for processing and analysis.

Soil samples collected from the study area were processed and stored for further analysis. The details of the standard methods adopted are given below. The processed dry soil samples were analysed for soil fertility parameters.

Soil pH was determined for 1:2.5 soil: water suspension by using digital pH meter (Systronics, Model 361) fitted with combined electrodes (Jackson, 1973). Soil organic carbon was estimated by wet oxidation method (Walkley and Black, 1934). Free $CaCO_3$ content by acid titration (Richards, 1954) [18] and the micronutrient cations were extracted with DTPA buffer at1:2 soil to extractant ratio (Lindsay and Norvell, 1978) [9] and measured using Micro wave Plasma- Atomic Emission Spectrometer (MP-AES, Agilent Technologies). Fertility status of zinc, iron, copper and manganese interpreted as deficient and sufficient by following the criteria given below (Arora, 2002) [3].

Statistical analysis

The data obtained were subjected to statistical tests using Anova: single factor and descriptive statistical analysis. Simple correlation studies were also to understand the effect of different soil parameters on available nutrients.

Results and Discussion

Analysis of black soils of Bilagi and Bagalkot talukas for available-Fe content (DTPA-Fe) revealed that more than 2/3rd of the samples (68.7%) were observed in higher range (> 4.50 ppm) while, 27.2% of the samples were observed in medium range. Among land use categories, Maize/ ground nut-Onion cropping system recorded significantly higher amounts of DTPA-Fe with a mean value of 5.63 ±1.84 ppm and it was on par with sugarcane cropped area (5.38 ± 1.76 ppm). However, dryland based jowar area showed lesser DTPA-Fe (4.88±1.64 ppm). These variations in DTPA-Fe content may be attributed to alteration in soil pH (Punithraj *et al.*, 2012; Shivakumar and Nagaraja, 2016) [7, 11, 20] and soil organic matter contents (Sharanbhoopal Reddy *et al.*, 2012) [14]. The solubility of iron bearing minerals and hence, its availability is largely influenced by soil pH and soil organic matter (Lindsay, 1979; Obreza *et al.*, 1993) [10, 12].

In terms of DTPA-Mn, all the soil samples were observed in medium to higher range of available-Mn (DTPA-Mn). DTPA-Mn ranged from 2.31-18.51 ppm. Lesser amounts of DTPA-Mn were recorded in jowar area (2.31 ppm) while, higher amounts of DTPA-Mn 18.51 ppm was found in sugarcane cropping system. Sugarcane cropping area recorded higher amounts of DTPA-Mn with a mean value of 9.06 ± 3.68 ppm. However, jowar cropping area were observed with lower amounts of DTPA-Mn (6.59 ± 2.58 ppm). The variations in DTPA-Mn among different land use may be attributed to the effect of pH, anaerobic conditions in micro-environments (Lamture and Patil, 2015; Anushree *et al.*, 2018; Nagaraja *et al.*, 1997) [8, 2] and high biomass turnovers (Punithraj, 2012). The solubility of DTPA-Mn increased with decrease in pH, decrease in Eh and organic molecules (acids) produced during decomposition (Chouhan *et al.*, 2012) [5]. The applied fertilizers especially urea, ammonium sulphate etc might have caused soil acidity in micro environments resulting in its higher availability (Anita *et al.*, 2018) [1].

The DTPA-Zn was found in the range of 0.39 to 3.56 ppm. Most of the soils samples (n=85) studied recorded medium range of DTPA-Zn (0.6-1.5 ppm). Maize /groundnut –Onion area recorded higher amounts of DTPA-Zn (1.79 ± 1.00 ppm) compared to sugarcane cropped areas (1.47 ± 0.57 ppm). However, lesser amounts of DTPA-Zn was found in jowar cropping area (0.61 ± 0.19 ppm). These variations among different irrigation system may be attributed to different soil environment factors such as pH and soil organic matter (Lamture and Patil, 2015) [8]. Alternate wetting and drying cycles under rainfed conditions in dryland areas is also known to precipitate zinc as ZnO and thereby, reduces its availability (Pulakeshi *et al.*, 2012) [13]. Varying amounts of carbonates and bicarbonates in dryland areas and borewell irrigated areas might have altered the availability-Zn (Ravikumar *et al.*, 2007; Kirankumar *et al.*, 2016) [5, 7, 17]. Higher availability of Zn in maize and sugarcane cropping system may be attributed to direct application of $ZnSO_4$ (Vijayashekar *et al.*, 2000) [24].

The availability of DTPA-Cu in most of the soils was found in medium to higher range. Similar to other micronutrients, DTPA-Cu was also found low in dryland areas compared to irrigated soils. With respect to DTPA-Cu nearly 83 per cent of samples were in higher range (>1.6 ppm). 15 per cent of samples were in medium range (0.8-1.6 ppm). Higher amounts of DTPA-Cu were found in Maize/ groundnut-Onion cropping area (3.27 ± 1.39 ppm) and it was on par with Sugarcane cropping system (2.67 ± 0.8 ppm). However, DTPA-Cu was significantly lesser in jowar cropping area (1.76 ± 0.65 ppm). This may be due to the presence of carbonates and bicarbonates in soils and its effect on pH and solubility of minerals might have reduced DTPA-Cu in dryland soils (Rekha *et al*, 2016; Shreekanth *et al*, 2018) [17, 21]. The same factors might have influenced the available-Cu content among different cropping systems (Lindsay, 1979) [10]. Interms of cropping systems the availability of Zn, Cu and Fe was found in the order of Sugarcane=Maize/ groundnut-Onion> Jowar cropping systems.

Brady and Weil, 1999 reported that Influence of soil factors like pH, $CaCO_3$ and SOC may be attributed to the variation in the available micro nutrient content among different cropping systems. The solubility of minerals in influenced by soil pH and the availability of micronutrients are also reported by Anita *et al*., 2018 [1]. The metal ions remain as respective hydroxides at higher pH and thereby their availability decreases (Lindsay, 1979) [10]. Similar observations on low availability of micronutrients in alkaline and calcareous soils have been reported by Singh *et al.*, 1980 [23]; Singh *et al.*, 2013 [22]; and Anita *et al*, 2018 [1].

Table 1: Critical concentrations of DTPA – extractable micronutrients in soils

DTPA-micronutrient	Low	Medium	High
Iron (Fe)	< 2.5	2.5 – 4.5	> 4.5
Manganese (Mn)	< 2.0	2.0 – 4.0	> 4.0
Zinc (Zn)	< 0.6	0.6 – 1.5	> 1.5
Copper (Cu)	< 0.8	0.8 – 1.6	> 1.6

Table 2: Available micronutrient status among different cropping systems of black soils of Bilagi and Mudhol taluka

Cropping system	Number of samples representing micronutrient availability status in soils			
	Low	**Medium**	**High**	**Mean ± SD**
DTPA extractable-Fe	**<2.50 ppm**	**2.50-4.50 ppm**	**>4.50 ppm**	
Jowar (n = 40)	2 (1.4)	12 (8.2)	26 (17.6)	4.88 ± 1.64[b]
Maize / groundnut – Onion (n = 7)	0	2 (1.4)	5 (3.4)	5.63 ± 1.84[a]
Sugarcane (n = 100)	4 (2.7)	26 (17.6)	70 (47.7)	5.38 ± 1.76[a]
Total (n =147)	6 (4.1)	40 (27.2)	101 (68.7)	
DTPA extractable-Mn	**<2.0**	**2.0-4.0**	**>4.0**	
Jowar (n = 40)	0	7 (4.7)	33 (22.5)	6.59 ± 2.58 [b]
Maize / groundnut – Onion (n = 7)	0	0	7 (4.7)	7.94 ± 1.71[ab]
Sugarcane (n = 100)	0	8 (5.5)	92 (62.6)	9.06 ± 3.68[a]
Total (n =147)	0	15 (10.2)	132 (89.8)	
DTPA extractable-Zn	**<0.60**	**0.60-1.50**	**>1.50**	
Jowar (n = 40)	25 (17.1)	15 (10.2)	0	0.61 ± 0.19[b]
Maize / groundnut – Onion (n = 7)	0	3 (2.1)	4 (2.7)	1.79 ± 1.00[a]
Sugarcane (n = 100)	1 (0.7)	67 (45.5)	32 (21.8)	1.47 ± 0.57[a]
Total (n =147)	26 (17.7)	85 (57.8)	36 (24.5)	
DTPA extractable-Cu	**<0.80**	**0.80-1.60**	**>1.60**	
Jowar (n = 40)	**3 (2.0)**	16 (10.9)	21 (14.2)	1.76 ± 0.65 [b]
Maize / groundnut – Onion (n = 7)	0	0	7 (4.8)	3.27 ± 1.39 [a]
Sugarcane (n = 100)	0	6 (4.1)	94 (64.0)	2.67 ± 0.88 [a]
Total (n =147)	3 (2.0)	22 (15.0)	122 (83.0)	

Note: 1. Values in parenthesis depict per cent; 2. Different letters mean column implies significant difference (at $P \leq 0.005$)

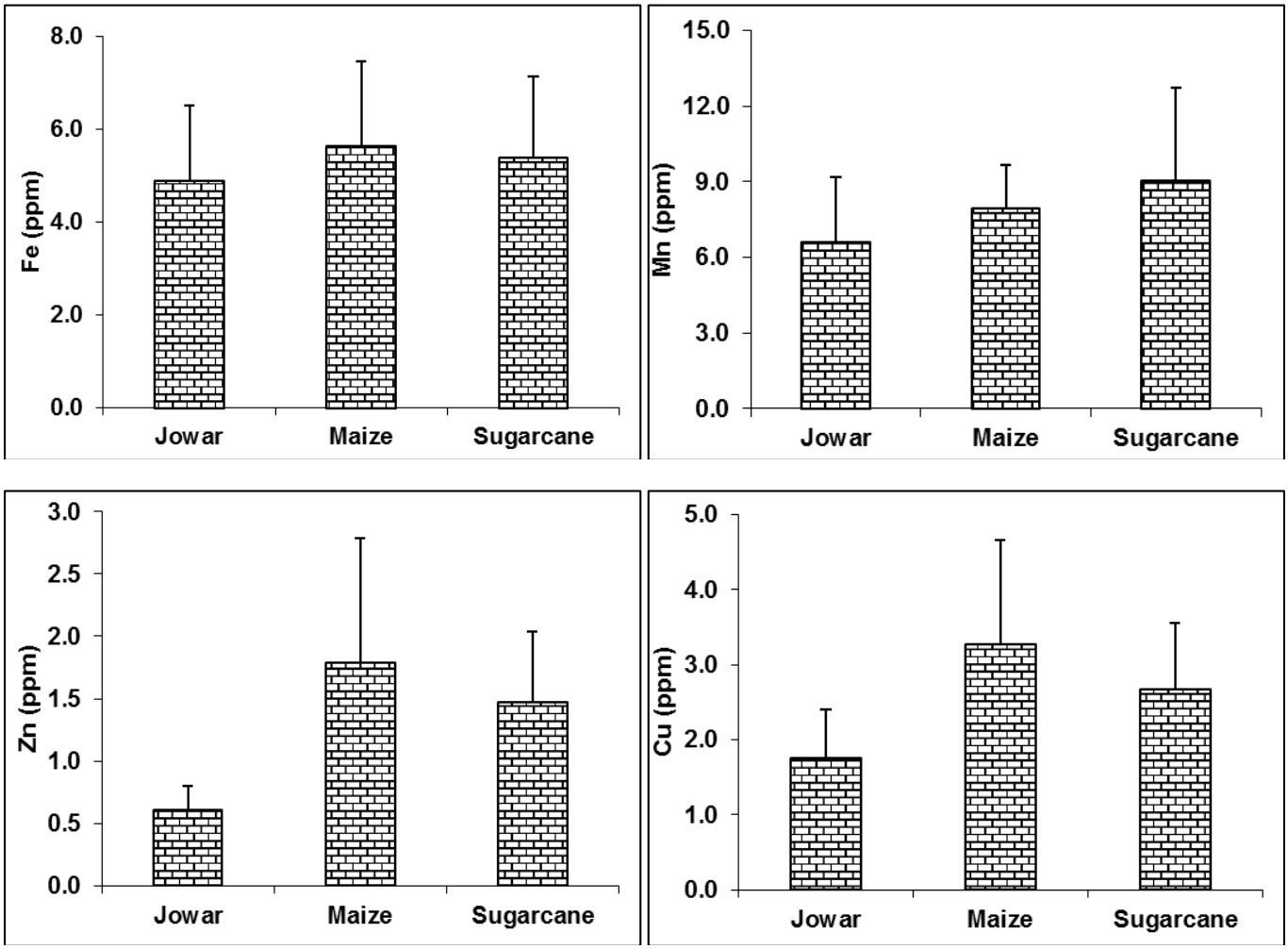

Fig 1: Micronutrient content in black soils of Bagalkot and Bilagi taluk under different cropping systems

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