

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.910.050>

Comparative Analysis of Nutrient Availability Status among Different Cropping Systems in Black Soils of Bilagi and Bagalkot

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ABSTRACT

Keywords

Major nutrients,
Black soils,
Cropping systems,
CaCO₃, SOC

Article Info

Accepted:
04 September 2020
Available Online:
10 October 2020

A survey based study was carried out to assess the nutrient availability status in jowar, maize/groundnut-onion and sugarcane based cropping systems in black soils of Bilagi and Bagalkot. Surface soil samples (0-15 cm) were collected from 147 grids of 5.06 sq km each and analyzed for available major and secondary nutrients. Among different cropping systems, available-N was found significantly higher (375.6 ± 27.6 kg N ha⁻¹) in soils of sugarcane, available-P was found significantly higher (40.7 ± 11.7 kg P₂O₅ ha⁻¹) maize/groundnut-onion cropping system and available-K was found significantly higher (395.1 ± 43.1 kg K₂O ha⁻¹) in Jowar system. Distribution of available-Ca and Mg contents did not show any significant differences among different cropping systems. Available-S was in medium range (10-20 ppm) in nearly 2/3rd of soil samples studied. The variations in soil available nutrient contents could be largely attributed to different levels of nutrient applications and crop uptake.

Introduction

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. In recent years, its importance is also recognized in maintaining human and animal health. It is very much evident that the soil's native ability to supply nutrients in sufficient quantity has declined over years due to intensive crop production (Nagaraja *et al.*, 2016). It is necessary to sustain the productive capacity of our fragile soils to support the food and fibre demand of our growing population.

Black soils are the important soils in semi-arid dry land agriculture as they are the most productive soils. The major contributing factor for the productivity of black soils in semi-arid environment is their high water holding capacity. These black soils have a capacity to store sufficient water for crop production. In arid and semi-arid areas, besides the concern over water and nutrient management, the growing land degradation process due to chemical soil degradation (salinization and/or sodification) also contributes to aggravate the unsustainable and variable declining crop yields.

Essential nutrient availability and uptake is highly influenced by soil conditions. In black soils, nitrogen loss through volatilization process and phosphorus fixation through its reaction with free calcium decreases the availability (Bhardwaj *et al.*, 2016). Further, high pH and presence of CaCO₃ reduces the availability of micronutrients through sorption and precipitation process (Sehgal, 1991). Thus, understanding the basic chemical properties of black soils is essential to overcome these constraints and come out with proper management of these soils for their sustainable and efficient utilization (Richards, 1954). Black soils have inherent constraints due to their typical physical and chemical characteristics which can affect the crop productivity (Anita *et al.*, 2018). Thus, the present study in Bilagi and Bagalkot talukas was carried out to assess soil fertility of black soils through soil survey.

Materials and Methods

Study area and cropping systems

Soil survey was carried out in Bilagi and Bagalkot talukas (Bagalkot district) of Northern Karnataka. Bagalkot district is situated at 16° 20' N and 75° 24' E in northern Karnataka with a total geographical area of around 6.5 lakh ha. The Bagalkot district falls under semiarid region and the mean annual temperature (last 10 year) varied from 30.2 to 32.6°C. The average annual precipitation was about 447.3mm and nearly 90 per cent of it is received during monsoon season.

The study was restricted to area with black soils. Sugarcane, jowar and maize/ groundnut-onion were the major cropping systems. Based on cropping system, the study area was grouped into three categories. These criteria were overlaid on 2.25 × 2.25 Sq.km grid maps of Bilagi and Bagalkot talukas. Each grid was identified as a study unit and the prominent

cropping system in that unit was considered in categorizing them.

Collection of soil samples

The toposheets of Bilagi and Bagalkot (1:50,000 scale) with the existing grids of 4.5 x 4.5 km² (20.25 Sqkm) were split into to 4 equal units of 2.25 x 2.25 km² 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. From each of these locations, 3 surface soil samples (0-15 cm) were collected as replications and made into one representative composite sample. The representative soil samples were air dried, sieved (2mm) and stored for further analysis.

Processed soil samples were analyzed for Soil pH (1:2.5 soil:water ratio) by potentiometric method, electrical conductivity by EC meter (Jackson 1973); Soil organic-C was estimated by wet oxidation method (Walkley and Black, 1934) and free CaCO₃ content by acid titration (Richards, 1954). For major nutrients, the alkaline permanganate method (Subbiah and Asija,1956), ammonium molybdate method (Jackson,1973) and flame photometric method were used for the determination of available – N, P₂O₅ and K₂O (Jackson, 1973). The secondary nutrients namely, exchangeable – Ca and Mg were determined by versenate titration (Jackson, 1973) while, turbidometric method was adopted for available-S (Black, 1965) respectively.

Statistical analysis

The soil analytical data 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

Availability of major nutrients

Nitrogen, phosphorus and potassium availability among three different cropping systems are given in Table 1 and their mean values are depicted in Fig. 1. Available nitrogen content in soils of different land use categories ranged from 197.5 to 450.0 kg N ha⁻¹. Among 147 samples analyzed, 87 per cent of the samples (n=127) recorded medium levels of available nitrogen (280-560 kg N ha⁻¹) while, the remaining samples had <280 kg of nitrogen ha⁻¹.

Among different cropping systems, soils from sugarcane system recorded significantly higher amounts of available-N contents (375.1 ± 27.64 kg N ha⁻¹) and the value were found on par with maize-groundnut cropping system. However, jowar cropping system recorded least available N values (309.9 ± 54.5kg N ha⁻¹). Higher amounts of available-N in sugarcane and Maize/ groundnut –onion cropping system may be attributed to both higher soil organic-C contents and high N fertilizers additions (Reddy *et al.*, 2012; Nagaraja *et al.*, 2018).

Available phosphorus content in black soils of Bilagi and Bagalkot irrigated with different sources of water is presented in Table 1. It ranged from 18.7 to 67.1kg P₂O₅ ha⁻¹. Nearly 83per cent of soil samples (n=121) recorded medium levels of available-P (22.9 to 56.3 kg P₂O₅ ha⁻¹). Only 5 per cent soil samples recorded higher-P availability (>56.3 kg P₂O₅ ha⁻¹). Maize / groundnut – onion cropping system recorded significantly higher availability phosphorus content (40.7 ± 11.7

kg P₂O₅ ha⁻¹) and it was found on par with sugarcane cropping system. Least available phosphorus (29.0 ± 7.4 kg P₂O₅ ha⁻¹) was recorded in jowar cropping system.

The available-phosphorus contents varied significantly in different cropping systems. Among plant nutrients, the phosphorous is highly active and its availability is determined by constituents of soil solution especially, carbonates, bicarbonates, iron and calcium contents in their active forms (Rekha *et al.*, 2018). However, free CaCO₃ had no significant influence on phosphorus availability in this study.

The available potassium among different cropping systems ranged from 236.5 to 486.1 kg K₂O ha⁻¹. More than 2/3rd of the analyzed samples (n=103) recorded higher potassium availability (>336 kg K₂O ha⁻¹) while, 1/3rd of the samples recorded medium range of available potassium. None of the soil samples were observed in lower range of available potassium (<144 kg K₂O ha⁻¹). Jowar based cropping system recorded significantly higher available potassium contents (395.1 ± 43.1 kg K₂O ha⁻¹) followed by maize / groundnut - onion (376.0 ± 49.3 kg K₂O ha⁻¹) and sugarcane (361.5 ± 55.4 kg K₂O ha⁻¹) systems.

The potassium content in maize-ground-nut system was found on par with other two cropping systems. The black soils are inherently possess high available-K₂O contents (Doddamani, 1994; Kirankumar *et al.*, 2015).

Many of the farmers have given less importance for the application of potassium through fertilizers. Continuous cultivation of sugarcane with less or no applications of potassium might have reduced available-K₂O content in soils (Babu *et al.*, 2010).

Table.1 Extent of major and secondary nutrients availability among different cropping systems in Bilagi and Bagalkot talukas

Cropping system	Number of samples with different availability ranges <i>w.r.t.</i>								
	Nitrogen (kg N ha ⁻¹)			Phosphorus (kg P ₂ O ₅ ha ⁻¹)			Potassium (kg K ₂ O ha ⁻¹)		
	< 280 (Low)	280– 560 (Medium)	>560 (High)	< 22.9 (Low)	22.9 – 56.3 (Medium)	>56.3 (High)	< 144 (Low)	144 - 336 (Medium)	>336 (High)
Jowar (n = 40)	10 (6.8)	30 (20.4)	0	12 (8.1)	28 (19.0)	0	0	4 (2.7)	36 (24.5)
Maize / groundnut – Onion (n = 7)	0	7 (4.7)	0	0	5 (3.4)	2 (1.4)	0	1 (0.7)	6 (4.1)
Sugarcane (n = 100)	10 (6.8)	90 (61.3)	0	9 (6.1)	88 (59.8)	3 (2.1)	0	39 (26.5)	61 (41.5)
Total (n =147)	20 (13.6)	127 (86.4)	0	21 (14.2)	121 (82.3)	5 (3.5)	0	44 (29.9)	103 (70.1)
Cropping system	Number of samples with different availability ranges <i>w.r.t.</i>								
	Calcium (meq 100 g ⁻¹)			Magnesium (meq 100 g ⁻¹)			Sulphur (mg kg ⁻¹)		
	< 24 (Low)	24 – 32 (Medium)	>32 (High)	< 6.0 (Low)	6.0 – 8.0 (Medium)	>8.0 (High)	< 10.0 (Low)	10.0-20.0 (Medium)	> 20.0 (High)
Jowar (n = 40)	0	13 (8.8)	27 (18.3)	2 (1.4)	0	40 (27.2)	4 (2.7)	32 (21.7)	4 (2.7)
Maize / groundnut – Onion (n = 7)	0	1 (0.7)	6 (4.0)	0	0	7 (4.7)	0	4 (2.7)	3 (2.1)
Sugarcane (n = 100)	0	21 (14.2)	79 (53.7)	0	3 (2.1)	99 (67.3)	5 (3.4)	53 (36.1)	42 (28.6)
Total (n =147)	0	35 (23.9)	112 (76.1)	2 (1.4)	3 (2.1)	142 (96.5)	9 (6.1)	89 (60.5)	49 (33.4)

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

Fig.1 Available major nutrient status among different cropping systems

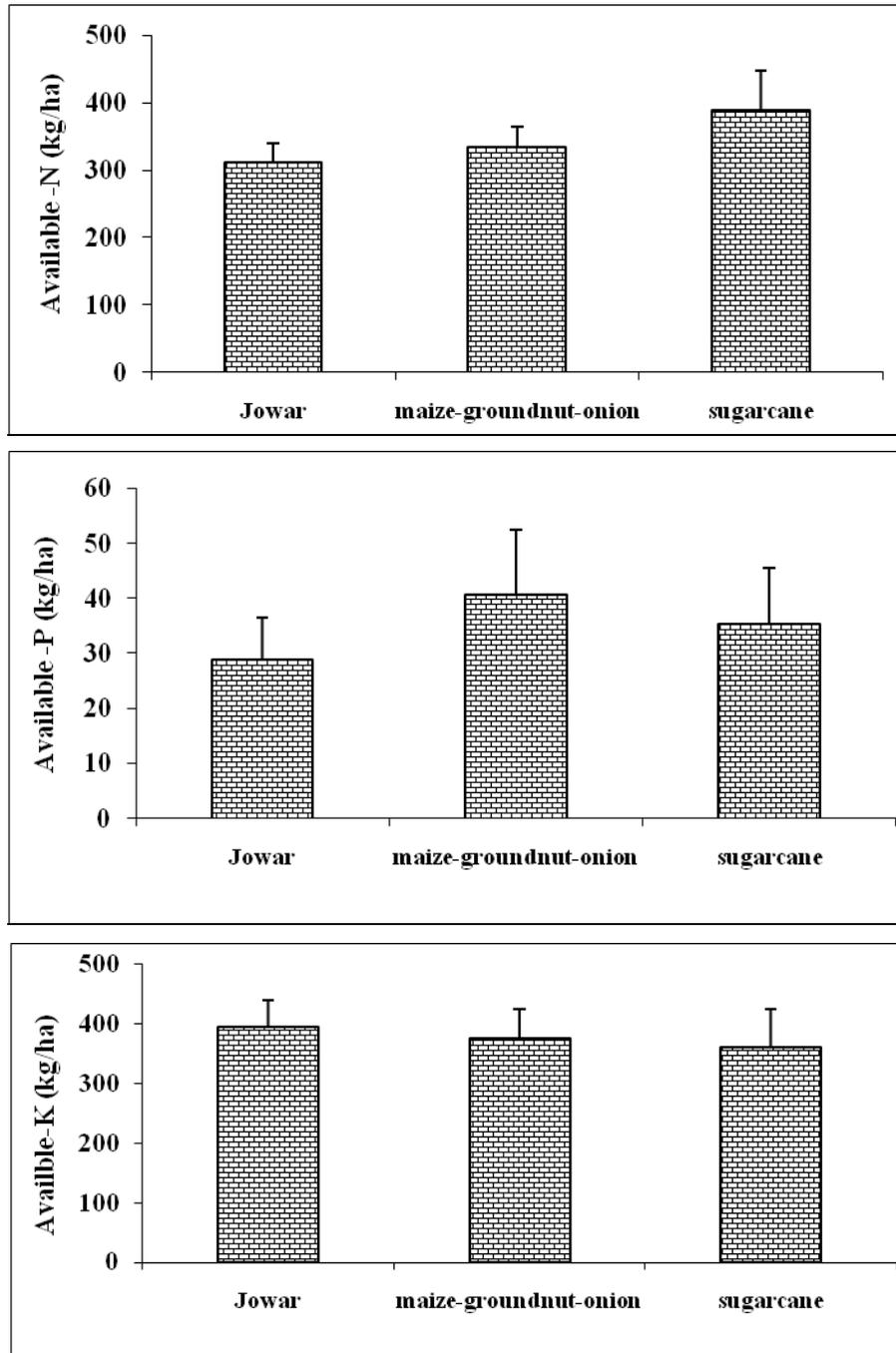
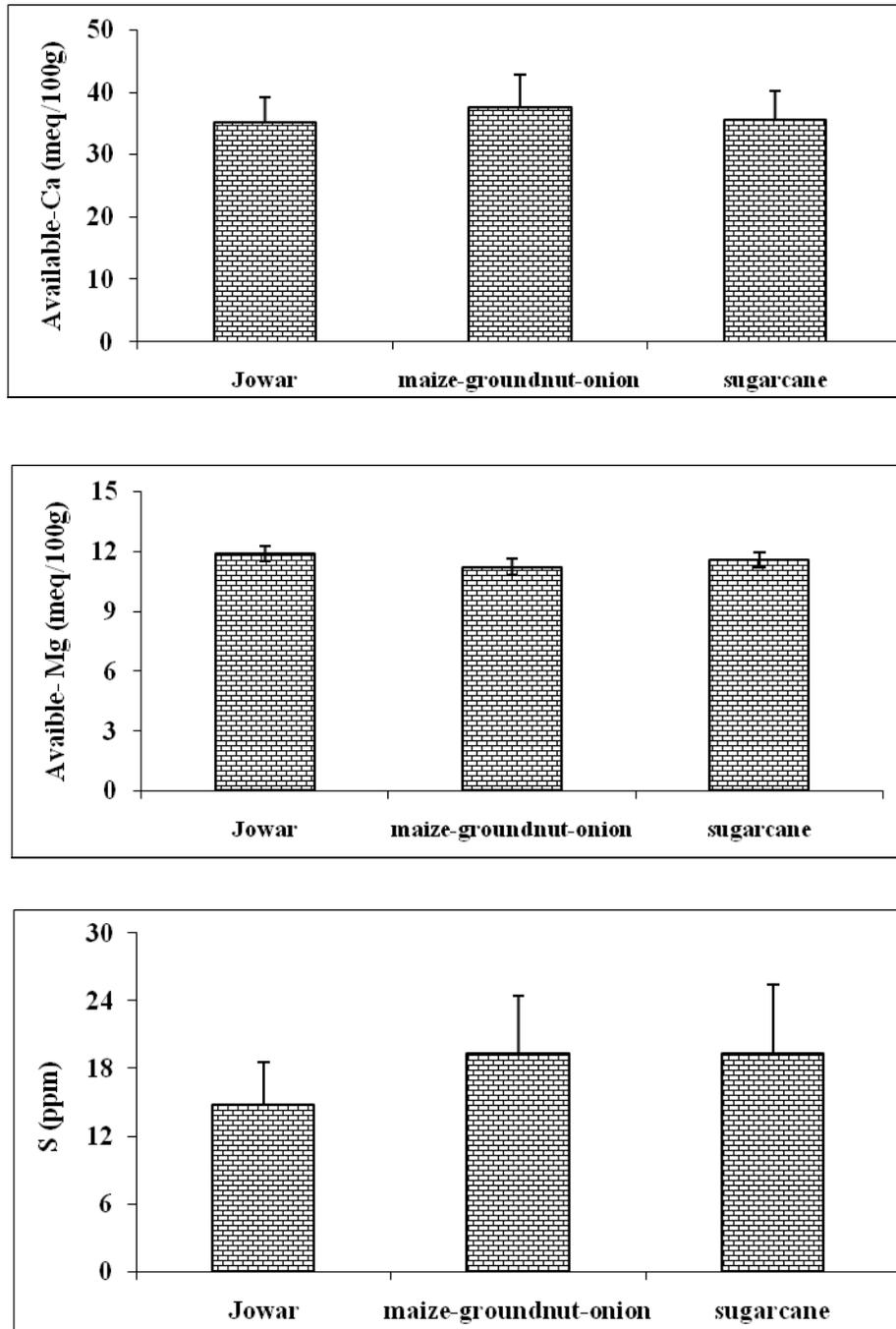


Fig.2 Available secondary nutrient status among different cropping systems



Availability of secondary nutrients

The distribution status of available-Ca, Mg and S content among different cropping systems of black soils of Bilagi and Bagalkot talukas are presented in Table 1 and their respective mean values are depicted in Figure 2. The available-Ca content ranged from 26.15 to 46.83 meq 100 g⁻¹ and it did not vary significantly among different cropping systems.

The available-Mg content ranged from 7.40 to 18.78 meq 100g⁻¹. More than 2/3rd of the soil samples (99 %; n=146) were in higher (> 8.0meq 100 g⁻¹) available-Mg while, only 2 samples were observed with <6.0meq of Mg 100 g⁻¹ soil. Application of magnesium salt is a common practice in these calcareous soils and thus, the crop removal might have been compensated (Anita *et al.*, 2018). However, no significant differences were found across land use categories both in terms of cropping systems (Rekha *et al.*, 2018).

The available sulphur in soils ranged from 8.01 to 34.56 ppm. In terms of its availability, nearly 2/3rd of soil samples recorded medium sulphur availability (10- 20ppm-S). Interestingly 1/3rd of the soil samples had > 20 ppm-S and belonged to higher range. Among different cropping systems, soils of sugarcane system and maize / groundnut – onion system recorded significantly higher amounts of available-S with respective values of 19.37 ± 6.09 and 19.38 ± 5.11 ppm. Jowar cropping system areas recorded significantly lower amounts of available sulphur (14.76 ± 3.76 ppm). Application of sulphur containing fertilizers in sugarcane and maize- ground nut/ onion systems might have resulted in observing higher sulphur contents compared to jowar cropping system where sulphur is not applied (Raj *et al.*, 2012; Rekha *et al.*, 2015). The availability of both major and secondary nutrients (except Ca and Mg) varied among

different three cropping systems studied. The variations in soil available nutrient contents could be largely attributed to different levels of nutrient applications and crop uptake.

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How to cite this article:

Sharanagouda, S. M., Priyanka B. Patil and Anita Kondi, E. 2020. Comparative Analysis of Nutrient Availability Status among Different Cropping Systems in Black Soils of Bilagi and Bagalkot. *Int.J.Curr.Microbiol.App.Sci.* 9(10): 409-416.
doi: <https://doi.org/10.20546/ijemas.2020.910.050>