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Black soil type of Haveri district, Karnataka- A study on selected physico-chemical properties

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Abstract
The different physico-chemical properties of twenty representative black soil types spreading over seven taluks of Haveri district of Karnataka were studied during 2016-17 at UAS, Dharwad. The experimental data related to pH of the black soils varied from 7.00 to 7.85. The lowest and highest pH was obtained in Mannangi-1 and Devihosur for surface soils, respectively. The EC of the black soils varied from 0.22 to 0.35 dS m^{-1}. The lowest and highest EC was obtained in Bankapur-1 and Mannangi-1 soils, respectively. Organic carbon was more in Hangal soil (7.98 g kg^{-1}) and less in Karadagi soils (3.65 g kg^{-1}). The data on particle size distribution of black soil revealed that the sand content ranged from 25.53 to 43.14 per cent, silt content varied from 18.50 to 25.47 per cent and clay content varied from 37.21 to 48.89 per cent. The mean contents of sand, silt and clay were 34.07, 21.88 and 43.24 per cent, respectively. The CEC of black soils ranged from 23.64 to 46.78 cmol (p^+) kg^{-1} in surface layer. Jogihalli-4 soil recorded highest CEC while, lowest CEC was noticed in Mannangi-2 soil. The black soil EPP ranged from 4.70 to 12.36 per cent with a mean of 8.04. The PAR of black soils in surface soils ranged from 1.00 to 3.58 with a mean of 2.25. The values of sum of exchangeable cations in surface black soils varied from 21.76 to 44.41 cmol (p^+) kg^{-1}. The available potassium in black soil varied from 322.56 to 752.64 kg ha^{-1} in surface layer. The highest available potassium was obtained in Jogihalli-4 and corresponding lowest value in Hangal soil. These soils varied appreciably in their physico-chemical properties depending on their clay mineralogy and management practices.

Keywords: physico-chemical properties, potassium

Introduction
Soil is a three dimensional complex matter which comprises of minerals, soil organic matter, water and air. These fractions greatly influence soil texture, structure, and porosity. These properties subsequently affect air and water movement in the soil layers, and thus the soil's ability to function. Therefore, soil physico-chemical properties have a greater influence on the soil quality. Soil texture especially can have a profound effect on many other properties. Thus, soil texture is considered one of the most important physical properties of soil. In fact, soil texture is a complex fraction, consisting of three mineral particles, such as sand, silt and clay. These particles vary by size and make up the fine mineral fraction. Farmers rely on pH testing to maintain quality soil that will produce the healthiest crops. The pH is master variable in soil, knowledge regarding pH helps in management of plant nutrients and their dynamics. The electrical conductivity of soil shows among other properties depending on temperature very interesting effects, which can be used technically. Soil organic carbon (SOC) is one of the major pools of carbon. The SOC pool is about double the size of the atmospheric carbon pool and about 3 times the size of the biotic carbon pool. Cation Exchange Capacity (CEC) is a measure of the ability of soil to hold positively charged ions. It is very important soil property influencing soil structure stability, nutrient availability, soil pH and reaction to fertilisers and other ameliorants. The surface of an individual clay particle or organic colloid is negatively (-) charged. As a consequence their surfaces attract and adsorb positively charged ions called cations. When water is added to soil, cations can move into solution, however, they are still attracted to the clay particle or organic colloid surface and as a result swarm around them. As rocks break down into the particles of sand, silt and clay that make up soil, potassium and other elements are released and may become available to plants. It is important to assess the quantity of potassium in the soil solution and the readily available pool to ascertain whether or not to apply potassium fertilizer. Hence, an immense study was undertaken to study the physico-chemical properties of maize growing black soils of Haveri district, Karnataka.

Result and Discussion
Material and Methods
The surface (0-20 cm) samples was collected, based on predominance of soil type and

dominance of cropped area (*i.e*., clayey black soils) under maize. The soil samples collected were air dried in shade, gently ground using wooden pestle and mortar and passed through 2 mm sieve. The sieved samples were preserved in polythene plastic covers for further analysis. Soil reaction was determined in 1:2.5 soil water suspension after stirring for 30 minutes using a pH meter (Jackson, 1973). It was determined in 1:2.5 soil: water suspension after obtaining supernatant as described by Jackson (1973) using conductivity meter. Organic carbon was determined by Walkley and Black's wet oxidation method as described by Piper (1996). The per cent distribution of particles of different size *viz.*, sand, silt and clay was determined by mechanical analysis using Bouyoucos Hydrometer method (Jackson, 1973). Soils (50 g) were shaken with 100 ml of 5 per cent solution of sodium hexa meta phosphate. Later, per cent silt and clay was estimated by hydrometer and per cent sand was calculated by subtracting silt and clay from 100. The exchangeable calcium and magnesium were determined in the neutral normal ammonium acetate the aliquot of the extract was titrated against standard versenate solution and sodium and potassium were determined by flame photometry (Jackson, 1973). Available potassium was determined by extracting soil with neutral normal ammonium acetate and the contents of K in solution and was estimated by flame photometery (Jackson, 1973). The exchangeable potassium percentage in soils was determined with following formula (U.S.D.A, 1954).

$$\text{EPP} = \frac{\text{Exchangeable K}}{\text{CEC}} \times 100$$

The potassium adsorption ratio in selected soils was calculated by following formula (U.S.D.A, 1954).

K

$$\text{PAR} = \frac{\text{K}}{\sqrt{\frac{(\text{Ca}+\text{Mg})}{2}}}$$

Results and Discussion

In the present study, pH of black soils varied from 7.00 to 7.85 with a mean of 7.53. The lowest and highest pH was obtained in Mannangi-1 and Devihosur soils, respectively. The good amount of basic cations and good amount of organic carbon may be the reason for neutral pH. The varied level of soil reaction might be mainly due to development of these soils from parent material ranging from acidic to basic nature. The variation may be due to fact that difference in contents of total exchangeable bases. Results are in corroboration with findings of Jagadeesh (2003) [2]. The EC of the black soils varied from 0.22 to 0.35 dS m^{-1} with a mean of 0.28. The lowest and highest EC was obtained in Bankapur-1 and Mannangi-1 soils, respectively. The electrical conductivity values were well within the range in both the soils at both the depths indicating that no harmful effects of salts, which depict that soils are well drained. Organic carbon was more in Hangal soil (7.98 g kg^{-1}) and less in Karadagi soils (3.65 g kg^{-1}) with a mean of 6.78 g kg^{-1}. The black soil organic carbon values were low to high due to regular addition of organic substances to these soils and also might be due to high moisture retension of black soils and lesser oxidation rate (Xiaolin *et al.*, 2016) [9]. The data on particle size distribution of black soil revealed that the sand content ranged from 25.53 to 43.14 per cent, silt content varied from 18.50 to 25.47 per cent and clay content varied from 37.21 to 48.89 per cent. The mean contents of sand, silt and clay were 34.07, 21.88 and 43.24 per cent, respectively. The samples were clay loam to clay in texture. The higher sand content was observed in Mannangi-2 and corresponding lower sand content was recorded in Jogihalli-4 soil. The lower silt content was recorded in Bankapur-2 soil and higher sand content was noticed in Jogihalli-4 sample. The surface low clay content was observed in Mannangi-2 soil and high in Jogihalli-4 soil. The variation may be because of chemical weathering resulted in formation of finer particles. The values were found to be in line with results obtained by Singh and Mishra (2012) [7]. The CEC of black soils ranged from 23.64 to 46.78 cmol (p$^+$) kg^{-1} with a mean of 38.53 cmol (p$^+$) kg^{-1}. Jogihalli-4 soil recorded highest CEC while, lowest CEC was noticed in Mannangi-2 soil. The high clay content and its high specific surface area, high organic matter content and black soils are dominated by 2:1 type of clay minerals would have resulted in higher CEC. The results obtained were on par with the findings of Vinay (2007) [8] and Rajagopal *et al*. (2013) [4]. The black soil EPP ranged from 4.70 to 12.36 per cent with a mean of 8.04. The highest was recorded in Byadgi-1 soil and lowest was recorded in Hanumanamatti soils. The lower values of EPP may be attributed to high electrostatic attraction offered by clays present in black soils. The results are in corroboration with findings of Shainberg *et al.* (2004) [6]. The PAR of black soils ranged from 1.00 to 3.58 with a mean of 2.25. The PAR value was obtained lowest in Hangal soil. While, highest was recorded in Rattihalli-5 soil. The higher values could be attributed to presence of smectite and illite clay minerals in black soils, stronger than that of kaolinite type of clay minerals present in red soils in providing stronger adsorption sites (Rahaman and Rowell, 1979) [3]. The values of sum of exchangeable cations in surface black soils varied from 21.76 to 44.41 cmol (p$^+$) kg^{-1} with a mean of 35.64 cmol (p$^+$) kg^{-1}. The highest value was obtained in Jogihalli-4 soil and lowest value in Mannangi-2 soil at both the depths. The higher values of exchangeable cations in black soils at surface depth may be due to fact that these soils provide high clay per cent with more surface area and exchange sites. These results were on par with the results of Yawson *et al.* (2011) [10]. The available potassium in black soil varied from 322.56 to 752.64 kg ha^{-1} in surface layer. The highest available potassium was obtained in Jogihalli-4 and corresponding lowest value in Hangal soil. The higher values of potassium indicated that these soils were regularly added with sufficient quantities of potash fertilizers. Similar results were obtained by Ravikumar (2004) [5] and Deshmukh (2012) [1].

Conclusion

In present study, the major soil type i.e., black soil type under maize cultivation was evaluated for selected important physico-chemical properties of Haveri district (Karnataka). The soils varied appreciably in their physico-chemical properties. The study revealed that variation in physico-chemical properties was be due to cultural practices, application of fertilizers, organic manures and other inputs.

Table 1: Details of soil samples collected from different places (black type) of maize growing areas of Haveri district, Karnataka

Sl. No.	Taluk	Location	Latitude	Longitude
1	Shiggoan	Bankapur-1	15° 02’ 52.1’’	75° 15’ 16.1’’
2	Shiggoan	Bankapur-2	15° 02’ 20.5’’	75° 15’ 55.0’’
3	Savanur	Karadagi	15° 01’ 21.3’’	75° 14’ 40.0’’
4	Savanur	Mannangi-1	14° 53’ 05.3’’	75° 17’ 39.7’’
5	Savanur	Mannangi-2	14° 52’ 58.7’’	75° 17’ 37.7’’
6	Savanur	Savoor	14° 53’ 42.8’’	75° 17’ 28.0’’
7	Haveri	Haveri	14° 53’ 45.0’’	75° 27’ 54.1’’
8	Haveri	Devihosur	14° 53’ 40.4’’	75° 29’ 41.7’’
9	Hangal	Hangal	14° 59’ 13.2’’	75° 57’ 32.5’’
10	Byadgi	Kaginelli	14° 51’ 28.2’’	75° 44’ 32.0’’
11	Hirekerur	Rattihalli-1	14° 51’ 18.2’’	75° 44’ 32.0’’
12	Hirekerur	Rattihalli-2	14° 51’ 36.3’’	75° 39’ 36.1’’
13	Hirekerur	Rattihalli-3	14° 51’ 21.0’’	75° 33’ 39.4’’
14	Hirekerur	Rattihalli-4	14° 52’ 29.9’’	75° 33’ 40.2’’
15	Hirekerur	Rattihalli-5	14° 49’ 32.0’’	75° 33’ 42.0’’
16	Hirekerur	Rattihalli-6	14° 49’ 34.2’’	75° 33’ 46.0’’
17	Hirekerur	Jogihalli-1	14° 45’ 10.6’’	75° 39’ 36.8’’
18	Hirekerur	Jogihalli-2	14° 52’ 48.8’’	75° 30’ 33.0’’
19	Hirekerur	Jogihalli-3	14° 52’ 52.1’’	75° 30’ 32.2’’
20	Hirekerur	Jogihalli-4	14° 45’ 14.0’’	75° 39’ 11.9’’

Table 2: Physico-chemical properties in selected maize growing red soils of Haveri district, Karnataka

Sample No.	$pH_{1:2.5}$	$EC_{1:2.5}$ (dS m^{-1})	OC (g kg^{-1})	Sand	Silt	Clay	EPP	CEC	Sum of Exch. Cations	PAR	Available K_2O (kg ha^{-1})	Textural class
				%				[cmol (p^+) kg^{-1}]				
1	7.60	0.22	5.94	29.80	21.80	47.45	5.55	44.98	43.80	1.74	430.28	c
2	7.20	0.26	6.20	41.34	18.50	38.97	9.43	27.14	25.79	2.24	426.64	cl
3	7.40	0.28	4.88	35.86	20.14	42.45	8.71	35.45	32.86	1.65	452.81	c
4	7.00	0.35	6.41	31.62	23.15	44.11	7.81	40.16	39.09	1.95	483.84	c
5	7.77	0.26	6.64	43.14	19.27	37.21	10.65	23.64	21.76	1.58	376.32	cl
6	7.35	0.25	7.12	33.49	20.35	45.78	4.70	42.54	40.05	1.52	420.08	c
7	7.68	0.28	7.01	39.78	21.01	39.10	12.36	24.26	22.89	2.27	483.84	cl
8	7.85	0.26	7.14	30.25	24.17	44.30	8.29	42.21	38.55	1.64	489.27	c
9	7.38	0.28	7.98	33.50	23.14	42.74	4.82	41.89	39.25	1.00	322.56	c
10	7.48	0.33	7.01	38.56	19.31	41.85	7.57	33.14	31.95	2.06	432.08	c
11	7.62	0.27	6.14	32.01	20.47	46.74	9.03	44.25	42.31	2.16	645.12	c
12	7.65	0.29	6.47	28.63	25.10	45.97	6.05	42.27	24.21	3.28	645.12	c
13	7.60	0.32	6.24	39.76	19.94	40.25	9.16	32.74	30.24	3.34	591.36	c
14	7.61	0.30	6.98	34.66	21.98	41.97	6.54	38.18	36.32	2.75	537.60	c
15	7.63	0.29	7.41	32.22	23.80	42.50	9.58	41.85	39.57	3.58	722.64	c
16	7.54	0.31	6.66	33.30	22.79	42.70	10.69	42.06	39.26	2.71	698.88	c
17	7.65	0.25	7.23	33.02	22.94	42.95	7.35	41.21	39.41	2.55	591.36	c
18	7.61	0.30	7.08	32.83	20.63	46.48	5.85	43.86	41.49	1.92	483.84	c
19	7.58	0.27	7.22	32.18	23.81	42.46	7.11	42.18	39.61	2.51	596.15	c
20	7.58	0.30	7.96	25.53	25.47	48.89	9.57	46.78	44.41	2.59	752.64	c
Range	7.00-7.85	0.22-0.35	4.88-7.98	25.53-43.14	18.50-25.47	37.21-48.89	4.70-12.36	23.64-46.78	21.76-44.41	1.00-3.58	322.56-752.64	Clay loam to clay
Mean	7.53	0.28	6.78	34.07	21.88	43.24	8.04	38.53	35.64	2.25	529.53	
S.D.	0.19	0.031	0.72	4.47	2.04	3.03	2.08	6.88	7.13	0.67	120.65	

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