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**Soumya Kulkarni**  
 Department of Soil Science and  
 Agricultural Chemistry,  
 College of Agriculture, Raichur  
 University of Agricultural  
 Sciences, Raichur, Karnataka,  
 India

**Ravi MV**  
 KVK Head, Gangavathi,  
 Karnataka, India

**Narayanarao K**  
 Professor and Head, Department  
 of Science and Agril. Chemistry,  
 College of Agriculture, Raichur,  
 Karnataka, India

**Umesh MR**  
 Assistant Professor, Department  
 of Agronomy, College of  
 Agriculture, Raichur,  
 Karnataka, India

**Corresponding Author:**  
**Soumya Kulkarni**  
 Department of Soil Science and  
 Agricultural Chemistry,  
 College of Agriculture, Raichur  
 University of Agricultural  
 Sciences, Raichur, Karnataka,  
 India

## Physico-chemical properties and distribution of nutrients in different type of calcareous vertisols

**Soumya Kulkarni, Ravi MV, Narayana Rao K and Umesh MR**

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### Abstract

A survey work was conducted during summer season of 2013 in different type of calcareous soils from Raichur, Shahapur and Surpur (Sholapur) taluks and was investigated in order to provide detailed information on their physico-chemical properties and nutrients distribution. The clay content of slightly, moderately and strongly calcareous soils are relatively high (>40%). The average soil reaction from slightly, moderately and strongly calcareous soils 8.04, 8.47 and 8.43, respectively. These soils were slightly saline to saline and organic carbon for these soils remained low to medium. Average cation exchange capacity value was highest in strongly calcareous soils (67.85 c mol kg<sup>-1</sup>) followed by moderately (66.37 c mol kg<sup>-1</sup>) and slightly calcareous soils (56.18 c mol kg<sup>-1</sup>). The CaCO<sub>3</sub> content variation in these soils may be due to parent material, native CaCO<sub>3</sub> content in soil profile and arid and semiarid climate. The available nutrients like N, P, K, S and micronutrients are low in strongly calcareous soils followed by moderately and slightly calcareous soils. Available nutrients relatively high in case of slightly calcareous soils. Higher values of exchangeable Ca and Mg were recorded in strongly calcareous soils.

**Keywords:** Calcareous soils, physico-chemical, nutrients

### Introduction

Calcareous soils are common in arid and semi-arid climates affecting over 1.5 billion acres of land worldwide. These soils are identified on the basis of presence of the mineral calcium carbonate in the parent material and an accumulation of lime. Calcite and aragonite (CaCO<sub>3</sub>), dolomite [CaMg(CO<sub>3</sub>)<sub>2</sub>] and Magnesite (MgCO<sub>3</sub>) are the calcium and magnesium carbonate minerals found in calcareous soils. They are mainly present as calcite, and to a lesser extent as dolomite. It is most easily recognized by the effervescence or fizz that occurs when these soils are treated with dilute acid (Agriculture Canada, 1976 and Soil Science Society of America, 1997) [2, 15]. The pH of these soils is usually above 7.0 and may be as high as 8.5 (Yaalon, 1957) [16]. When such soils contain sodium carbonate, the pH may exceed 9.0. Calcareous soils are classified in to four classes based on the presence of calcium carbonate percent in them and they are slight (0-5%), moderate (5-10%), high (10-20%) and very high calcareous soils (20-25%). Calcareous soils are productive for agricultural use when they are managed properly. This review will outline the physico-chemical properties and distribution of different nutrients of different type of calcareous Vertisols.

### Materials and Methods

The survey work was conducted during summer season of 2013 to collect representative (No.45) surface soil samples of different calcareous soils in Raichur, Shahapur and Surpur (Sholapur) taluks. Further they were subjected to chemical analysis and categorized in to slightly, moderately and strongly calcareous soils with respect to per cent calcium carbonate status.

### Soil sample collection and chemical analysis

The collected samples were air-dried, ground and passed through a 2 mm sieve and stored in polythene bags for further analytical work. Sand, silt and clay contents were separated by the International pipette method (Piper, 1966) [14]. The pH and EC of soils was measured in 1:2.5

soil water suspension using a glass electrode and Conductivity Bridge, respectively (Jackson, 1973). The organic carbon content of the soil was estimated by Walkley and Black's wet oxidation method as described by Jackson, 1973 [8]. Calcium carbonate in soil was determined by rapid acid titration method. Cation Exchange Capacity was determined by sodium saturation method and flame photometer was used to determine sodium. (Black, 1965) [5]. The available nitrogen was determined by alkaline potassium permanganate method and Available phosphorus in soil was extracted by Olsen's extractant and phosphorus was determined by stannous chloride molybdophosphoric blue color method (Hesse, 1971) [7]. Available potassium were extracted with neutral normal ammonium acetate solution and using flame photometer. Available sulphur was estimated by turbidometry method using spectrophotometer at 420 nm (Black, 1965) [5]. Exchangeable calcium and magnesium in soil was determined by following versenate titration method (Jackson, 1973) [8]. DTPA extractable micronutrients like zinc, iron, copper and manganese was determined using Atomic absorption Spectrophotometer as described by Lindsay and Norvell (1978) [10].

## Results and Discussion

Survey was conducted during summer season of 2013 in calcareous soil area of Raichur, Shahapur and Surpur

(Shorapur) taluks. Physico-chemical properties and nutrients distribution of slightly, moderately and strongly calcareous soils were given in Table 1 and 2.

### Physico-chemical properties of different type of calcareous soils

Physico-chemical properties of slightly, moderately and strongly calcareous soils were given in Table 1.

Majority of the soils (slightly, moderately and strongly calcareous soils) texture comes under silty clay and clay category (Table 1) may due to more clay content (more than 40 per cent) and clay was dominated by montmorillonite (Basavaraj, 2000) [4]. Slightly, moderately and strongly calcareous soils were alkaline in reaction ranged from 7.88 to 8.33, 8.24 to 8.74 and 8.04 to 8.70, respectively. Being predominated by calcium carbonate, it was logical that pH of these soils were alkaline. Similar analytical result for soil pH in calcareous soils was reported by Afifet *al.* (1993) [1]. The electrical conductivity of slightly, moderately and strongly calcareous soils ranged from 0.11 to 0.14, 0.12 to 0.53 and 0.19 to 1.22 dS m<sup>-1</sup> respectively due to prevailing arid climate with low rain fall favoured for accumulation of salts from the soil profile and favoured the soil to become saline. Average EC value was highest in strongly calcareous soils (0.42 dS m<sup>-1</sup>) followed by moderately (0.23 dS m<sup>-1</sup>) and slightly calcareous soils (0.12 dS m<sup>-1</sup>).

**Table 1:** Physico-chemical properties of different types of calcareous soils

Name of the location	Sand (%)	Silt (%)	Clay (%)	Texture	pH	EC(dSm <sup>-1</sup> )	OC(g kg <sup>-1</sup> )	CEC(c mol (p <sup>+</sup> ) kg <sup>-1</sup> )	CaCO <sub>3</sub> (%)
<b>Slightly calcareous soils (NO. 15)</b>									
Range	16.25-21.45	21.33-31.87	46.72-60.58	Clay	7.88-8.33	0.11-0.14	3.1-6.0	53.4-60.9	3.49-5.00
Average	19.32	27.11	53.60		8.04	0.12	5.05	56.18	3.97
SD	1.54	3.13	3.62		0.138	0.01	1.02	2.09	0.36
<b>Moderately calcareous soils (NO. 15)</b>									
Range	12.08-23.5	24.64-30.92	50.43-59.71	Clay	8.24-8.74	0.12-0.53	4.0-6.1	60.5-71.6	7.65-9.60
Average	18.39	27.19	54.42		8.47	0.23	4.7	66.37	8.91
SD	3.67	2.00	2.69		0.13	0.12	0.64	3.57	0.651
<b>Strongly calcareous soils (NO. 15)</b>									
Range	8.85-20.24	21.95-33.16	53.36-68.75	Silty clay	8.04-8.70	0.19-1.22	3.2-5.7	60.5-72.6	11.25-20.55
Average	13.19	28.84	58.59		8.43	0.42	4.3	67.85	16.78
SD	3.26	3.04	3.59		0.18	0.24	0.73	3.08	2.68

Note: SC- silty clay, C- clay

Organic carbon for these soils remained low to medium (3.1 to 6.5, 4.0 to 6.1 and 3.1 to 5.7 g kg<sup>-1</sup> of slightly, moderately and strongly calcareous soils, respectively) due to insufficient availability of organic manures. Range of cation exchange capacity was found in slightly, moderately and strongly calcareous soils ranged from 53.4 to 60.9, 60.5 to 71.6 and 60.6 to 72.6 c mol (p<sup>+</sup>) kg<sup>-1</sup>, respectively (Table 1). This may due to presence of higher amount of calcium and other cations. Similar CEC for calcareous vertisols were presented by Afifet *al.*, 1993 [1]. Minimum, maximum and average calcium carbonate content in slightly calcareous soils was 3.49, 5.00 and 3.97 per cent, respectively. In moderately

calcareous soils, it was 7.65, 9.60 and 8.91 per cent, respectively and in strongly calcareous soils, it was 11.25, 20.55 and 16.78 per cent, respectively. The CaCO<sub>3</sub> content variation in these soils may be due to parent material, native CaCO<sub>3</sub> content in soil profile and arid and semiarid climate. Similar reports regarding the presence of calcium carbonate content in vertisols were reported by Halajinia *et al.* (2009) [6].

### Distribution of nutrients

Nutrient distributions of different type of calcareous soils were given in Table 2.

**Table 2:** Distribution of nutrients in different types of calcareous soils

Name of the location	Available(kg ha <sup>-1</sup> )			Available S(mg kg <sup>-1</sup> )	Exchangeable (c mol (p <sup>+</sup> ) kg <sup>-1</sup> )		DTPA extractable(mg kg <sup>-1</sup> )			
	N	P	K		Ca	Mg	Zn	Fe	Mn	Cu
<b>Slightly calcareous soils (NO. 15)</b>										
Range	255.0-401.4	28.4-35.6	333-447	13.9-21.7	10.0-39.5	2.5-15.0	0.28-0.78	2.03-2.90	2.00-2.49	0.28-0.65
Average	338.01	32.39	417.00	17.31	29.79	11.16	0.57	2.37	2.30	0.53
SD	41.20	2.41	31.39	2.37	9.45	4.19	0.11	0.26	0.14	0.09
<b>Moderately calcareous soils (NO. 15)</b>										
Range	238-355	17.2-25.4	252-423	10.0-17.1	14.0-43.5	2.5-17.5	0.45-0.56	1.99-2.50	1.48-2.02	0.48-0.55
Average	312.55	21.33	334	15.42	31.1	11.1	0.52	2.25	1.85	0.51

SD	28.92	2.67	57.63	1.97	9.71	4.12	0.04	0.16	0.19	0.02
Strongly calcareous soils (NO. 15)										
Range	200.7-351.2	14.2-22.5	215-385	9.98-16.9	20.0-45.5	7.0-13.5	0.40-0.56	2.00-2.38	1.49-2.01	0.20-0.61
Average	282.53	17.48	337.07	14.77	25.53	9.00	0.49	2.13	1.79	0.48
SD	46.11	2.53	43.27	2.22	5.82	1.64	0.06	0.11	0.21	0.13

Maximum average nitrogen was recorded in slightly calcareous soils (338.0 kg ha<sup>-1</sup>) followed by moderately (312.55 kg ha<sup>-1</sup>) and strongly calcareous soils (282.53 kg ha<sup>-1</sup>) and majority of the soils were belongs to category of low to medium in available nitrogen. The poor status of soil organic carbon resulted in low status of available nitrogen. The available phosphorus ranged from 28.4 to 35.6, 17.2 to 25.4 and 14.2 to 22.5 kg ha<sup>-1</sup>, respectively in slightly, moderately and strongly calcareous soils and implies that majority of the soils were low to medium in available phosphorus (Table 2). It may due to phosphorus fixation as Ca-P in soil resulted in low status of phosphorus. Similar result of low availability of phosphorus in calcareous soils was reported by Mostashari *et al.*, 2008<sup>[11]</sup>. Maximum available potassium was 483, 423 and 420 kg ha<sup>-1</sup>; minimum available potassium recorded was 333, 252 and 215 kg ha<sup>-1</sup> with an average of 417, 334 and 343.73 kg ha<sup>-1</sup>, respectively. These soils were high in potassium content as per soil test rating (> 280 kg ha<sup>-1</sup>). Kapoor *et al.* (1981), Pal (1985) and Patil and Sonar (1993)<sup>[9, 12, 13]</sup> stated that in high pH soils there could be greater dissolution of potassium bearing minerals leading to high potassium status. The available sulphur in slightly, moderately and strongly calcareous soils ranged from 13.0 to 21.7, 10.0 to 17.1 and 9.98 to 16.9 mg kg<sup>-1</sup>, respectively indicating that these soils were above critical level (10 ppm) (Basavaraj, 2000)<sup>[4]</sup>. Irrespective of different type of calcareous soil samples, the average of exchangeable calcium and magnesium in slightly, moderately and strongly calcareous soils were in high category as per soil test rating. The average exchangeable magnesium and calcium were 11.16 and 27.79 c mol kg<sup>-1</sup>, 11.10 and 31.10 c mol kg<sup>-1</sup> and 9.63 to 26.83 c mol kg<sup>-1</sup> in slightly, moderately and strongly calcareous soils, respectively. As soil pH increases from neutral to alkaline, the availability of exchangeable calcium and magnesium increases gradually (Bacchewar and Gajbhiye, 2011)<sup>[3]</sup>. The average DTPA-Zn in slightly calcareous soils (0.58 ppm) was greater than the moderately (0.52 ppm) and strongly (0.49 ppm) calcareous soils. The average values of these different types of calcareous soils were below the critical level (0.6 ppm) of DTPA-Zn. The average DTPA-Fe in slightly calcareous soils (2.37 ppm) was greater than the moderately (2.25 ppm) and strongly calcareous soils (2.13 ppm). The values were medium as per the soil test rating and also below the critical level (4.5 ppm) of DTPA-Fe. The average DTPA-Mn in slightly calcareous soils (2.30 ppm) was greater than the moderately (1.85 ppm) and strongly (1.79 ppm) calcareous soils. However, the DTPA-Mn at different type of soils was above the critical level (1.00 ppm) which is considered to be optimum for crop growth. The average DTPA-Cu in slightly calcareous soils (0.53 ppm) was greater than the moderately (0.51 ppm) and strongly (0.48 ppm) calcareous soils. However, the DTPA-Cu at different type of soils was above the critical level (0.2 ppm).

### Conclusion

Majority of the soils texture comes under silty clay to clay. Slightly, moderately and strongly calcareous soils were alkaline in reaction. These soils were slightly saline to saline and organic carbon status of calcareous soils remained low to

medium. Average cation exchange capacity value was highest in strongly calcareous soils (67.85 c mol kg<sup>-1</sup>) followed by moderately (66.37 c mol kg<sup>-1</sup>) and slightly calcareous soils (56.18 c mol kg<sup>-1</sup>). Calcareous soils contain less CaCO<sub>3</sub> ranged from 3.49 to 5.00 per cent with an average value of 3.47 per cent. The CaCO<sub>3</sub> content in moderately calcareous soils ranged from 7.65 to 9.61 per cent and in strongly calcareous soil was 11.25 to 20.55 per cent. Different type of calcareous soils belongs to low to medium in available nutrients i.e. N, P, K, S, Ca, Mg and micronutrients. Slightly calcareous soils had relatively more available nutrients (N, P, K, S and micronutrients) compare to moderately and strongly calcareous soils. Exchangeable Ca and Mg in strongly calcareous soils recorded more followed by moderately and slightly calcareous soils.

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