International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 1617-1620

Received: 21-07-2018
Accepted: 24-08-2018

Lakshmi PD
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Nagaraja MS
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Prasanna SM
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Shankar Meti
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Tanveer A
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Correspondence
Lakshmi PD
Department of Soil Science and Agricultural Chemistry, College of Horticulture, University of Horticultural Sciences, Bagalkot, Karnataka, India

Vertical distribution of cations and anions along the slope in a vertisol of dry land areas representing northern dry zone of Karnataka

Lakshmi PD, Nagaraja MS, Prasanna SM, Shankar Meti and Tanveer A

Abstract
Topography plays an important role in soil formation. It also determines the movement of water and dissolved salts within a soil system. A study was carried out in a vertisol of dryland areas of Hungund taluk. Three soil profiles were identified representing high (P_1: 530 m), mid (P_2: 520 m) and low (P_3: 510 m) elevations and profile samples were collected at 15cm depth intervals. The samples were analysed to assess pH, EC and water extractable cations and anions. The pH of soils of high elevations (P_1) were found highly alkaline while, soils of profiles-2 and 3 were moderately alkaline in reactions. Both the soil profiles recorded gradual increase in pH with depth. All the three soil profiles were found non-saline (< 4.0 dS m^{-1}) and indicated movement of salts to subsurface layers by percolating water. In terms of individual cations and anions, their concentrations were found in the order of $Na^+ > Ca^{2+} > Mg^{2+} > K^+$ and $Cl^- > SO_4^{2-} >$ total CO_3^{2-}+HCO_3^- respectively. Accumulation of sodium and total carbonates in surface soils at high elevation and their transport to subsurface layers might have induced higher SAR and RSC values. Introduction of irrigation into this black soil area is likely to alter the salt balance and induce salinity/ sodicity though they are non-saline at present.

Keywords: salinity, vertisols, water extractable ions, profiles, topography, dryland

Introduction
Chemical and physical properties of a soil depend on its topographical location of soil formation. The topography influence the microclimate, vegetation establishment and movement of matter and energy (Nagaraja *et al.*, 2016) [9]. The black soils of Northern dryzone of Karnataka are mostly derived from basaltic parent material and belong to the order of vertisols. The Krishna Bhagya Jal Nigam Ltd of Upper Krishna Project has introduced a large scale micro irrigation project at Hungund taluk covering about twenty six thousand ha to enhance water use efficiency. At present, traditional dryland crops of this region namely sunflower, chilli, sorghum, chickpea, soyabean etc are being provided with assured protective irrigation. Introduction of irrigation to a region is also likely to alter the salt balance in a given soil. Considering these facts, a base line study was carried out to assess the vertical distribution of salts in three soil profiles existing at different elevations.

Material and Methods
Study area: Hungund of Bagalkot district represents typical black soils of northern Karnataka and comes under Northern Dry Zone. The topography of the study area exhibits gentle to moderate undulations and experiences sub-tropical climate with dry semi-arid conditions the soils are mostly derived from basaltic parent materials. The mean annual temperature of the Hungund taluk ranged from 33 to 36 ^oC while, the annual precipitation is extremely low with average of rainfall of about 630 mm (last 10 years). Accumulation of salt is anticipated in these soils as the region experiences PET > RF. However, seasonal monsoon rainfall is likely to induce salts movement both laterally and vertically into subsurface layers.

Profile soil samples collection: Three profile sampling sites were identified to represent high (P_1: 530 m), mid (P_2: 520 m) and low (P_3: 510 m) elevations for the study to understand vertical distribution of salts along the slope gradient. Soil samples were collected at a fixed interval of 15 cm up to a depth of 1 m.

However, only three soil profile samples were collected from the third profile (P_3) as the soils were shallow in nature. The collected soil samples were air dried, mixed, sieved (2 mm) and stored about half a kg of soil for further analysis.

Determination of water extractable cations and anions

Extraction of cations and anions: Water soluble salts present in soil were extracted with distilled water at 1:2 soil and water ratio. Fifty gram soil was taken in a 250 ml conical flask and 100 ml of distilled water was added. The soil -water mixture was kept in vertical shaker for 30 minutes for shaking. The supernatant of the suspension was centrifuged for 20 minute at 1500 rpm and then filtered through Watman no. 42 filter paper to obtain the clear extract. These extracts were stored in refrigerator for further analysis. The soil samples were also analysed for pH and EC. Water extractable cations and anions were determined by adopting standard protocols (Table 1).

Results and Discussion

The results obtained on electro chemical properties and vertical distribution of cations and anions are presented under different headings.

Soil reaction (pH) and electrical conductivity (EC): The pH and electrical conductivity of three soil profiles are depicted in Table 2. The pH of soil samples in profile-1 (P_1) representing higher elevation were highly alkaline in reaction with pH values ranging from 9.12 to 9.46 at 0-15cm and 90-100cm soil depths respectively. However, the pH of soils of profile 2 (P_2) representing mid elevation was moderately alkaline on the surface while, subsurface soils were highly alkaline in reaction. The soil pH ranged from 8.86 to 9.39 at 0-15cm and 60-75cm depths. In both the profiles, the soil pH increased gradually from surface to subsurface soils. Contrastingly, the soil profile existing at lower elevation (P_3) recorded medium alkalinity and the pH decreased with depth. Higher alkalinity (pH 9.00 – 9.50) in profiles - P_1 and P_2 may be attributed to higher occurrence of total carbonates of sodium in higher amounts (Kirankumar *et al.,* 2015; Ashwin *et al.,* 2017) [10, 16, 1]. The observations were in concurrence with the amounts of above ions in the soil profile. The same factors might have induced higher alkalinity in subsoil layers also. The profile existing at lower elevations P_3 recorded moderate alkalinity which may be due to loss of carbonates and bicarbonates of sodium along with percolating water. This might be also due to the fact that the profile - 3 lies almost on the natural stream line which overflows during rainy season.

The electrical conductivity values of three soil profiles indicated that the soils were non- saline in nature at all depths. It was observed that the soils at higher elevations (P_1) recorded higher EC values compared to profile 2 samples. In both the profiles, the salinity increased with increase in depth. The transport of salts from surface to subsurface layers by percolating water during rainy season (Kadu *et al.,* 2013; Rekha *et al.,* 2015) [5, 10]. Contrastingly, soil profile (P_3) representing low elevations recorded lesser conductivity values. Higher amounts of cations and anions in subsurface soils of profile 1 and 2 also confirms the above results. Lower EC in profile 3 (P_3) may be attributed to loss of salts and their respective ions through percolating water. Higher EC values in profile 1 compared to profile 2 may be due to very deep clayey soils existing at high elevations. High capillary water movement along with dissolved salts both capillary and lateral movement of water might have altered salt balance (Chhabra, 1996; Rengasamy, 2010) [3, 11].

Water extractable cations and anions: The amounts of total cations and anions in soil profiles existing at different elevations are given in table 2 and distribution of individual ions are depicted in figure 2. The total cations and anions ranged from 9.53 to 14.04 meq/ l. Both total cations and anions were found higher in profiles 1 and 2 existing at high and mid elevation, while the profile 3 at low elevations had lesser amounts. In terms of individual cations and anions, their concentration were found in the order $Na^{+}> Ca^{2+}> Mg^{2+}> K^{+}$ and $Cl^{-}> SO_4^{2-}>$ total respectively. In general, the total cations and anions increased with depth. In all those samples, water extractable- Na, Cl and carbonates were found higher in all the soil profiles. Interestingly, water extractable-K was found least in all the soil profile samples. Similar observations were reported by Kiran *et al*. (2015) [6, 10] and Ashwin *et al.* (2017) [1].

The variations with represent to the total cations and anions are in concurrence with corresponding EC values indicating movement of salts to subsurface layers carried by percolating water (Minhas and Sharma, 2003) [8]. Lesser amounts of cations and anions in profile- 3 may also be due to leaching losses as it remains in saturated conditions during rainy season (Kuligod *et al.,* 2008) [7]. Varying concentrations of cations and anions i.e higher Na^{+}, Cl^{-} and total $CO_3^{2-} + HCO_3^{-}$ contents compared to lesser amounts of K^{+} and Ca^{2+} may be attributed to their adsorption abilities of ions onto the clay surface. Among water extractable ions, K^{+} and Ca^{2+} exhibit higher adsorption while, Na^{+} and Cl^{-} remain less preferred for exchange reactions.

Susceptibility of soils for sodification: Susceptibility for sodification is assessed by measuring the dominance of sodium over other ions through SAR and RSC values. Extent of variations in RSC and SAR among three soil profiles at different elevations are depicted in figure 3. The RSC values ranged from 0.22 to 1.12 meq/l while, SAR was in the range of 6.60 to 10.91 meq/l. The surface soils of profile-1 recorded higher values of both RSC and SAR values and it decreased with depth. Contrastingly, the profile- 2 recorded lesser values in surface soils and they increased with depth. However, no specific trend was observed in profile -3. Accumulation of sodium and total carbonates in the surface soil could be due to their higher solubility. It may also be due to high capillary evapo-transpiration rates in deep clayey soils (Chhabra, 1996) [3]. High leaching of Na^{+} and total carbonates to subsurface layers by percolating could be the reason for observing higher sodicity even in subsoils.

These results indicated that the present dryland areas of Hungund may not be saline at present however, the soils were found susceptible for sodification. Introduction of irrigations into this area is likely to alter the present salt balance and thus, the present study would serve as bench mark reference for future salinity assessment.

Table 1: Standard protocols adopted in determining soil salinity parameters

Parameter	Methodology	Reference
Soil reaction (pH)	By pH Meter for 1:2.5 soil-water suspension	Jackson, 1973 [4]
Soil salinity (EC)	By EC Meter for 1:2.5 soil-water suspension	
Water extractable-Ca	By Versanate titrations	(Baruah and Barthakur, 1999) [2]
Water extractable-Mg		
Water extractable-K	By Flame Photometry	Sharma *et al*., 1987 [12]
Water extractable-Na		
Water extractable total carbonates (CO_3+HCO_3)	By acid base titration (methyl orange indicator)	
Water extractable-Cl	By Mohr's $AgNO_3$ titration method	
Water extractable-SO_4	By Turbidometric method	

Table 2: Electro chemical properties of profile soil samples of a vertisol representing dryland areas of Hunugund

Soil Depth	pH			EC (dS m^{-1})			Total cations (meq l^{-1})			Total Anions (meq l^{-1})		
	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3	P_1	P_2	P_3
0-15 cm	9.12	8.86	8.68	0.27	0.13	0.10	13.03	11.83	10.64	12.61	11.30	9.25
15-30 cm	9.17	9.01	8.53	0.24	0.19	0.11	13.83	13.06	9.53	13.09	13.02	10.20
30-45 cm	9.29	9.08	8.40	0.35	0.24	0.11	13.43	14.04	11.07	13.96	14.09	10.55
45-60 cm	9.32	9.25	-	0.33	0.22	-	13.04	11.80	-	13.51	11.28	-
60-75 cm	9.34	9.39	-	0.39	0.23	-	13.26	13.83	-	13.88	13.42	-
75-90 cm	9.31	9.37	-	0.43	0.20	-	11.68	13.26	-	12.26	13.63	-
90-100 cm	9.46	9.36	-	0.18	0.19	-	12.53	12.95	-	12.49	13.29	-

Note: P_1, P_2 and P_3 represent soil profiles at high, mid and low elevations respectively

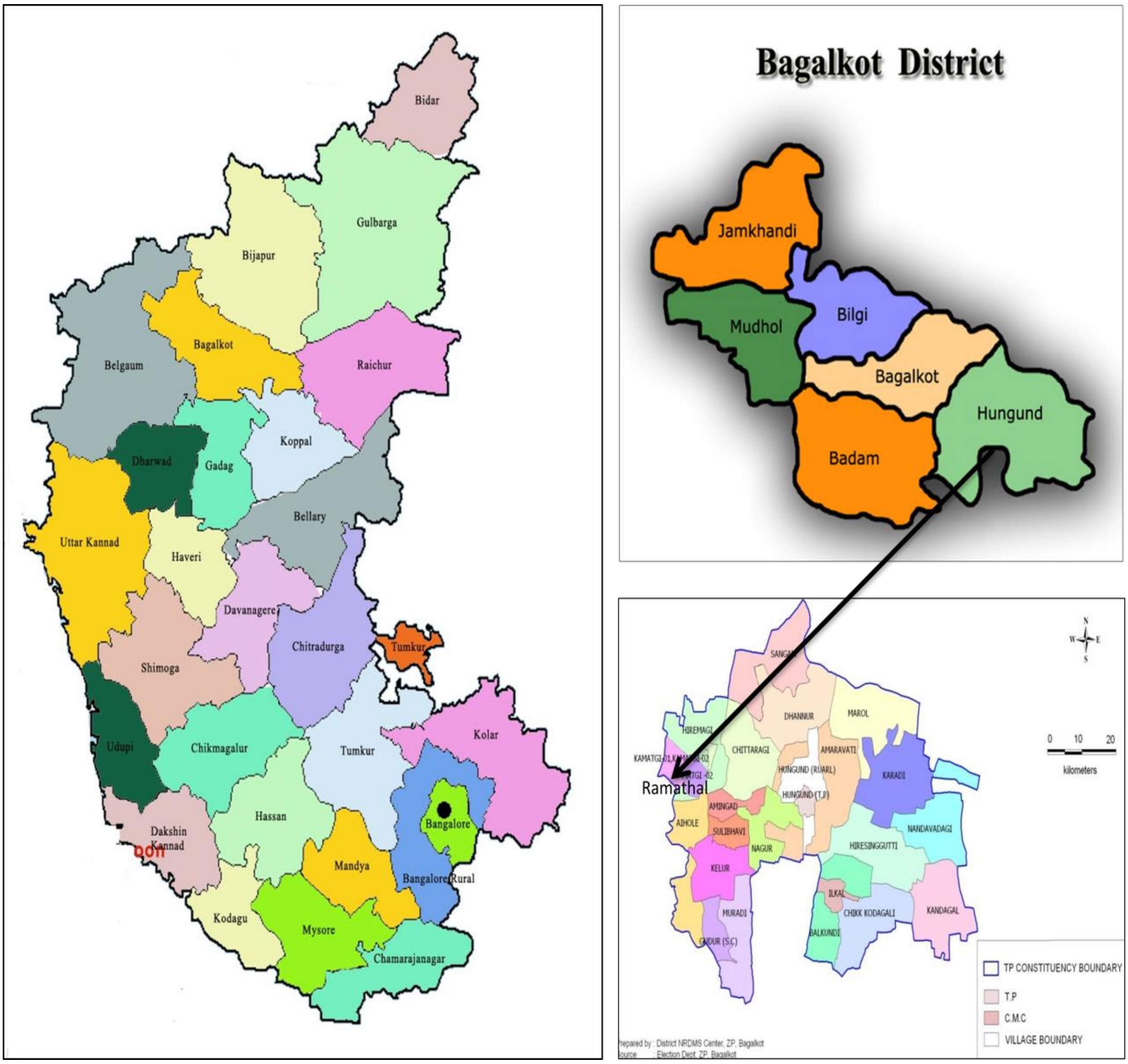

Fig 1: Location map of Ramthal study area

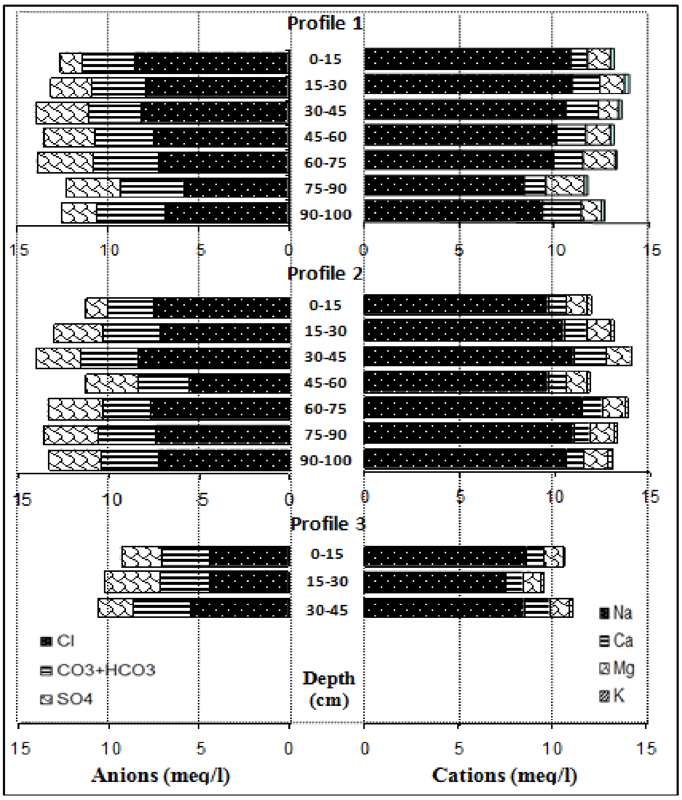

Fig 2: Vertical distribution of cations and anions in a vertisol representing dryland areas

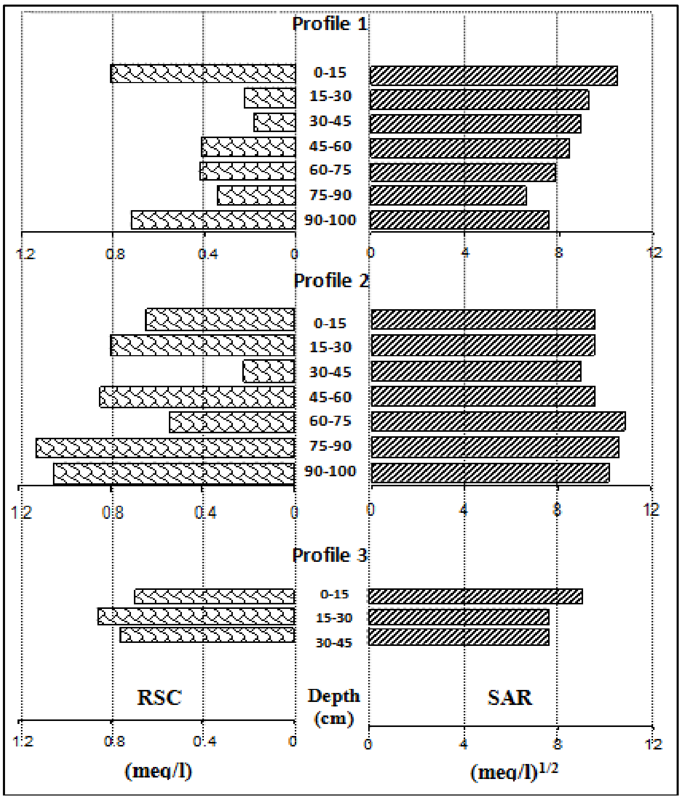

Fig 3: RSC and SAR values among soil profiles of vertisol representing dryland areas

References

1. Ashwin HS, Irappa Nagaral N, Ashok Alur S, Nagaraja MS. Effect of different irrigation water sources on soil sodification in typical black soils of Karnataka. International Journal of Current Research. 2017; 9:47278-47280.
2. Baruah TC, Barthakur HP. Text Book of Soil Analysis. Vikas publishing House Pvt. Ltd. New Delhi, 1999,
3. Chhabra R. Soil salinity and water quality, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi, 1996,
4. Jackson ML. Soil Chemical Analysis. Asia publishing house, New Delhi, 1973, 518.
5. Kadu PR, Giri JN. Assessment of soil degradation in vertisols of Upper Warda Command area, Maharashtra, India. Journal of Soil Salinity and Water Quality. 2013; 5:20-26.
6. Kirankumar S, Nagaraja MS, Suma R, Ashok Alur S. Extent of soil sodification as influenced by different irrigation water sources in a typical black soil of Karnataka. An Asian Journal of Soil Science. 2015; 10:159-162.
7. Kuligod VB, Dasog G, Vijayashekar K. Long term effect fo manures and fertilizers on sorghum-pulse productivity and soil nutrient status in canal command. Indian Journal of Agricultural Sciences. 2008; 78:498-504.
8. Minhas PS, Sharma OP. Management of soil salinity and alkalinity problems in India. Journal of Crop Production, 2003; 7:180-230.
9. Nagaraja MS, Bharadwaj AK, Prabhakara Reddy GV, Srinivasamurthy CA, Sandeep Kumar. Estimations of soil fertility in physically degraded agricultural soils through selective accounting of fine earth and gravel fractions. Solid Earth. 2016; 7:897-903.
10. Rekha MV, Kirankumar S, Ashok Alur S, Nagaraja MS, Suma R. Effect of irrigation water sources on micronutrients availability in a typical black soil of northern Karnataka. Andhra Pradesh Journal of Agricultural Sciences. 2015; 1:75-79.
11. Rengasamy P. Soil processes affecting crop production in salt-affected soils. Fundamentals of Plant Biology. 2010; 37:613-620
12. Sharma VAK, Krishnan P, Budhihal SL. Laboratory method., Technical Bulletin, No. 14, NBSS LUP. Nagpur, 1987, 89.