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# Physico-chemical characteristics of low activity clay soils of north Karnataka

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## Summary

**Low activity clay soils of north Karnataka were studied for their morphological, physical and chemical properties. Four pedons at Santur, Hosad, Valgalli and Hegale were dug open for the detailed study. These soils exhibited an advanced stage of weathering as evident from their deep profile. These soils exhibited better drainage, more redness and more amounts of gravels. The soil structure varied from sub angular blocky to granular. The uniform distribution of ferruginous gravels was one of the striking features of these soils. They were acidic, poor in bases with low cation exchange capacity. These soils were classified into Typic Kanhaplustalfs, Kanhaplic Haplustults, Rhodic Kandiustult and Lithic Kanhaploustults.**

*Key words : Clay soils; Low activity; Typic; Kanhaplic; Rhodic; Lithic.*

Low activity clay soils are those, which have a cation exchange capacity of less than 16 cmol (p+) $kg^{-1}$ clay and an effective cation exchange capacity (ECEC) of 12 cmol (p+) $kg^{-1}$ clay. The dominance of kaolinite and hydrous oxides of Fe and Al in the clay fraction results in such low exchange capacity of soils (Krishnan *et al.*2000). Widespread occurrence of these soils has been reported in the west coast region (Krishna, *et. al.*,1996) where the climatic conditions are condusive for the intense leaching and weathering of soils leading to the formation of highly weathered low activity clay soils. The low activity soils of the north Karnataka region are studied in this investigation for their physico-chemical characteristics.

## Experimental

Four pedons from Santur representing hills, Hosad representing pediments and Valgalli and Hegale representing plateau were used for the present study.

The study area is characterized by

high humidity with a mean annual rainfall of 3521 mm and with a mean annual air temperature of 27.6°C.

Soil morphological characteristics were described as per Soil Survey Manual (Soil Survey Staff, 1951). Particle size analysis of the sample was carried out by international pipette method (Jackson, 1969). The chemical characteristics of the soils including pH (1:2.5 soil water), organic carbon, exchangeable cations, 1*N* KCl $BaCl_2$-Tri Ethanol Amine($BaCl_2$-TEA) extractable acidity, cation exchange capacity and base saturation was carried out following standard methods (Black, 1965). CEC of the samples was also determined by sum of cations method (CEC-S) and ECEC, apparent CEC and apparent ECEC were worked out. Soil classification was done according to Soil Taxonomy (Soil Survey Staff, 1999).

## Results and Discussion

The data pertaining to the morphological properties and particle size distribution and given in (Table 1). All the pedons were deep except Hegale pedon. The colour of the Santur and Valgalli pedons were uniformly red to dark red with a constant chroma of 6. The colour was grayish brown in the surface horizons of Hosad and Hegale pedons which showed an increase in redness as the depth increased. The surface texture was clay loam in Santur pedons which changed to clay in the intermediate layers and clay loam in the lower most horizons. The surface texture was sandy loam in the Hosad and Hegale pedons. The structural development was good with subangular blocky structure in all the pedons except Hegale where granular structure was noticed. The dry consistency varied from slightly hard to very hard moist consistency from very friable to friable and wet consistency from slightly sticky to sticky and slightly plastic to plastic.

Accumulation of ferruginous coarse fragments were a common feature of these soils and they may be formed by dehydration of firagmented laterite debris (Venugopal and Koshy, 1985). The sand fraction varied from 15.1 to 6.10 per cent. The distribution of clay with depth in these soils indicates translocation of clay from A to B horizons.

The chemical characteristics of these soils are presented in (Table 2), pH of these soils in 1:2.5 water varied from 5.0 to 5.7. The organic carbon content (0.28 to 2.49 per cent) was more at the surface and showed a decrease with depth that might. be due to the leaching environment existing in the area. The exchangeable complex is mostly dominated by $Ca^{2+}$, $Mg^{2+}$, $Na^{+}$ and $K^{+}$ ions. The low content of exchangeable bases in all these pedons is due to high rainfall that caused intensive leaching of soils. The KCl acidity was more in Valgalli and Hegale pedon with low amount of exchangeable aluminium

**Table 1**

**Morphological properties and particle size distribution in soils**

| Horizon | Depth (cm) | Morphological properties | | | | Particle size distribution (%) | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Soil colour (Moist) | Texure | Structure | Consistency | Course Fragments (>2mm) | Sand (2-0.05mm) | Silt (0.05-0.002mm) | Clay (<0.002mm) |
| **Pedon 1 (Santur)** | | | | | | | | | |
| A1 | 0-7 | 2.5 YR 5/6 | vg cl | m3 sbk | sh, fr, ssps | 51.4 | 38.8 | 25.2 | 36.0 |
| AB | Jul-33 | 2.5 YR 3/6 | g c | m3sbk | vh,vfr,sps | 26.6 | 29.9 | 14.4 | 55.7 |
| Bt1 | 33-61 | 2.5 YR 3/6 | g c | m2bk | vh,vfr,sps | 23.3 | 21.2 | 12.2 | 66.6 |
| Bt2 | 61-86 | 2.5 YR 4/6 | g c | f2sbk | vh,fr,sps | 31.9 | 15.1 | 13.1 | 71.8 |
| BC1 | 86-122 | 2.5 YR 4/6 | vg cl | vf1sbk | sh,fr,sps | 46.7 | 38.3 | 23.0 | 38.7 |
| BC2 | 122-175 | 2.5 YR 4/6 | vg cl | vf1sbk | sh,fr,sps | 39.8 | 29.0 | 39.8 | 31.2 |
| **Pedon 2 (Hosad)** | | | | | | | | | |
| A1 | 0-10 | 10 YR 3/2 | vg sl | m3 sbk | sh,fr,ssp | 51.8 | 56.2 | 24.3 | 19.4 |
| Bt1 | 30-Oct | 10 YR 2/2 | vg c | m3sbk | vh,fr,ssp | 44.0 | 37.2 | 21.8 | 40.9 |
| Bt2 | 30-60 | 10 YR 3/3 | vg c | m2sbk | vh,vfr,ssp | 51.8 | 32.3 | 18.2 | 49.8 |
| Bt3 | 60-110 | 5 YR 4/4 | vg c | m2sbk | vh,fr,ssp | 68.7 | 31.9 | 10.5 | 57.6 |
| BC | 110-180 | 2.5 YR 4/6 | vg cl | m2sbk | h,fr,ssp | 50.1 | 44.9 | 23.1 | 31.6 |
| **Pedon 3 (Valgalli)** | | | | | | | | | |
| A1 | 0-20 | 2.5 YR 4/6 | vg sc | c3 sbk | vh,fr,ssp | 60.3 | 52.3 | 15.5 | 32.1 |
| BW1 | 20-48 | 2.5 YR 3/6 | eg sc | c3sbk | vh,fr,ssp | 63.9 | 53.6 | 7.7 | 38.7 |
| BW2 | 48-106 | 2.5 YR 3/6 | eg c | m3sbk | vh,fr,ssp | 72.1 | 44.4 | 10.9 | 44.7 |
| BC | 106+ | 2.5 YR 4/6 | eg cl | m1sbk | vh,vfr,ssps | 72.5 | 44.3 | 17.4 | 38.4 |
| **Pedon 4 (Hegale)** | | | | | | | | | |
| A1 | 0-18 | 10 YR 3/2 | g sl | m3gr | h,vfr, ssps | 32.4 | 61.0 | 18.6 | 20.4 |
| BW1 | 18-30 | 10 YR 3/4 | vg scl | m1gr | vh,fr, ssps | 47.6 | 57.6 | 17.1 | 25.1 |
| BW2 | 30-50 | 7.5 YR 4/4 | vg scl | m1sbk | h,fr, ssps | 59.2 | 58.3 | 16.3 | 33.4 |

* Abbreviations as per Soil Survey Manual (AIS & LUS 1970)

**Table 2**

**Chemical Properties of soils**

| Horizon | Depth (cm) | pH water (1:2.5) | Org. carbon (%) | Exchangcable bases | | | | KCl acidity | | | $BaCl_2$-TEA acidity | CEC $NH_4$ Oac | CEC -S | EC EC | Apparentment CEC | Apparentment ECEC | Base staturation | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Ca | Mg | Na | KCl acidity | Ex.H | Ex-Al | Total | | | | | | | $NH_4$-OA | Sum of cations |
| | | | | cmol $(p^+)kg^{-1}$ soil | | | | | | | | | | | cmol $(p^+)kg^{-1}$ soil | | % | |
| **Pedon 1 (Santur)** | | | | | | | | | | | | | | | | | | |
| A1 | 0-7 | 5.6 | 1.65 | 6.00 | 3.53 | 0.42 | 0.13 | 0.48 | 0.25 | 0.73 | 27.26 | 12.1 | 37.34 | 10.3 | 33.69 | 28.69 | 83 | 27 |
| AB | Jul-33 | 5.7 | 0.99 | 5.48 | 3.30 | 0.19 | 0.09 | 1.00 | 0.2 | 1.30 | 22.09 | 10.7 | 31.15 | 9.36 | 19.12 | 16.8 | 85 | 29 |
| Bt1 | 33-61 | 5.7 | 0.75 | 4.13 | 3.23 | 0.13 | 0.09 | 0.30 | 0.25 | 0.55 | 20.68 | 9.35 | 28.26 | 7.83 | 14.04 | 11.76 | 81 | 27 |
| Bt2 | 61-86 | 5.7 | 0.63 | 4.58 | 2.03 | 0.11 | 0.09 | 0.35 | 0.33 | 0.68 | 15.04 | 9.03 | 21.85 | 7.14 | 12.58 | 9.94 | 75 | 31 |
| BC1 | 86-122 | 5.4 | 0.84 | 5.23 | 3.83 | 0.09 | 0.08 | 0.83 | 0.14 | 0.97 | 12.69 | 11.7 | 21.92 | 9.37 | 30.18 | 24.21 | 79 | 42 |
| BC2 | 122-175 | 5.1 | 0.12 | 6.23 | 2.85 | 0.38 | 0.05 | 0.41 | 0.35 | 0.76 | 9.40 | 10.20 | 18.91 | 9.86 | 32.69 | 31.6 | 93 | 50 |
| **Pedon 2 (Hosad)** | | | | | | | | | | | | | | | | | | |
| A1 | 0-10 | 5.2 | 2.49 | 5.85 | 3.15 | 0.23 | 0.22 | 0.45 | 0.17 | 0.62 | 17.86 | 10.10 | 27.31 | 9.62 | 52.06 | 49.59 | 94 | 34 |
| Bt1 | 30-Oct | 5.3 | 1.80 | 5.03 | 2.70 | 0.19 | 0.18 | 0.45 | 0.15 | 0.60 | 17.39 | 9.00 | 45.49 | 8.25 | 22.00 | 20.17 | 90 | 32 |
| Bt2 | 30-60 | 5.5 | 1.26 | 4.88 | 2.63 | 0.19 | 0.15 | 0.60 | 0.45 | 1.06 | 13.63 | 9.45 | 21.48 | 8.30 | 18.98 | 16.6 7 | 83 | 37 |
| Bt3 | 60-110 | 5.7 | 1.81 | 4.73 | 3.38 | 0.14 | 0.11 | 0.65 | 0.30 | 0.95 | 12.22 | 10.3 | 20.58 | 8.66 | 17.83 | 15.03 | 81 | 41 |
| BC | 110-180 | 5.4 | 0.60 | 3.9 | 2.63 | 0.12 | 0.15 | 0.15 | 0.65 | 0.80 | 10.81 | 8.05 | 19.61 | 7.45 | 25.24 | 23.35 | 84 | 39 |
| **Pedon 3 (Valgalli)** | | | | | | | | | | | | | | | | | | |
| A1 | 0-20 | 5.3 | 1.38 | 2.49 | 2.25 | 0.28 | 0.67 | 0.80 | 0.03 | 1.90 | 11.75 | 6.68 | 17.43 | 5.71 | 16.00 | 15.86 | 88 | 33 |
| Bw1 | 20-48 | 5.4 | 0.81 | 1.35 | 1.28 | 1.21 | 0.26 | 1.60 | 0.10 | 1.70 | 12.69 | 5.83 | 16.79 | 4.20 | 15.06 | 10.86 | 70 | 24 |
| Bw2 | 48-106 | 5.4 | 0.45 | 1.35 | 1.65 | 1.27 | 0.68 | 1.53 | 0.02 | 1.55 | 9.87 | 6.58 | 14.82 | 4.97 | 14.72 | 11.12 | 75 | 33 |
| BC | 106 | 5.3 | 0.28 | 2.40 | 1.58 | 0.20 | 0.10 | 0.95 | 0.25 | 1.20 | 7.99 | 5.95 | 12.27 | 4.53 | 15.49 | 11.8 | 72 | 35 |
| | | | | | | | | | | | | | | | | | | |
| A1 | 0-18 | 5.2 | 0.90 | 1.50 | 1.20 | 0.13 | 0.07 | 0.30 | 0.10 | 0.40 | 9.4 | 3.88 | 12.23 | 2.93 | 19.02 | 14.36 | 75 | 24 |
| Bw1 | 18-30 | 5.1 | 0.62 | 1.58 | 0.90 | 0.11 | 0.01 | 1.11 | 0.30 | 1.41 | 5.17 | 3.85 | 7.77 | 2.90 | 15.34 | 11.55 | 68 | 23 |
| Bw2 | 30-50 | 5.0 | 0.41 | 2.85 | 0.75 | 0.09 | 0.09 | 1.10 | 0.15 | 1.25 | 11.75 | 4.68 | 15.53 | 3.93 | 14.9 | 11.77 | 81 | 24 |

indicating that they have undergone more weathering. The $BaCl_2$-TEA acidity was several times more than KCl acidity in all the pedons. This suggests that most of the fairly high $BaCh_2$-TEA extractable acidity of these soils can be attributed to Al or Fe hydroxy compounds that are held teraciously on the exchange complex (De Alwis and Pluth, 976) and due to non-exchangeable alrnninium embedded between crystal lattice. which came in to solution due to buffering and complexing nature of $BaCl_2$- TEA.

CEC-$NH_4OAc$ (3.85 to 12.13 cmol ($P^+$) $kg^{-1}$) was more than effective CEC (2.90 to 10.33 cmol ($p^+$) $kg^{-1}$). The low ECEC. despite high clay content and organic matter indicates that these soils are dominated by low activity clay minerals (patil and Dasog. 1999). The CEC-S were several times higher than the CEC-$HN_4OAc$ and ECEC values in all the pedons.

As evident from (Table 2), the Santur pedon meets the criteria for argillic and kandic horizon and hence qualified to be classified as Typic Kanhaplustalf. The Hosad pedon a keyed out as Kanhaplic Haplustults because of the presence of an argillic horizon. Kandic horizon and base saturation by sum of cation of less than 35 per cent Valgalli pedon keyed out as Rhodic Kandiustult due to the presence of an argillic horizon with base saturation of less the 35 per cent. a Kandic horizon and a, colour of 2.5 YR and redder in the uppper 100 cm of the Kandic horizon in more than 50 per cent, and a moist value of 3 and dry value not more than 1 unit high than moist value. The Hegale pedon was classified as Lithic Kanhaploustults owing to the presence of an argillic horizon with less than 35 per cent base saturation by sum of cations. a Kandic horizon and lithic contact within 50 cm of the surface.

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## References

ALS & LUS 1970 Soil Survey Manual (All India Soil and Land Use Survey Organization, New Delhi)

Black, C.A. 1965 Methods of Soil Analysis Part II, Chemical and Microbiological Properties. Agronomy Monograph No.9, American Society of Agronomy Inc. Madison, Wisconsin, USA.

| | | |
|---|---|---|
| De Alwise, K.A. and Pluth D.J. | 1976 | Soil Science Society of American Journal, 40,912-920. |
| Jackson, M.L. | 1969 | Soil Chemical Analysis Advanced course, 2nd Ed. 11th Printing Published by the author, Madison, WIS |
| Krishnan, P; Venugopal, K.R. and Nair, K.M. | 2000 | Journal of the Indian Society of Soil Science, 48, 819-823, |
| Krishnan, P; Venugopal, K.R. and Sehgal, J.L. | 1996 | NBSS Publ. 49 (b), NBSS & LUP, Nagpur. |
| Patil, P.L. and Dasog G.S. | 1999 | Agropedology, 9, 1-15 |
| Soil Survey Staff | 1951 | Soil Survery Manual.Agriculture Handbook No. 18, Washington DC, Oxford and Ibh Pub. Co., New Delhi. |
| Soil Survey Staff | 1999 | Soil Taxonomy- Second edition, Agricultural Handbook No. 436, Washington, D.C., USA. |
| Venugopal, V.K. and Koshy, M.M. | 1985 | Agricultural Research Journal of Kerala, 23, 9-16 |