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Characterization, Classification and Fertility of *Bangalore Blue* Grapes Growing Soils of Karnataka

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Abstract

A study was carried out to characterize and classify major *Bangalore Blue* grapes-growing soils of Karnataka and to assess the inherent fertility of these soils for cultivation. Four locations were selected on the basis of concentration of *Bangalore Blue* grapes-growing areas of Karnataka and delineated based on the variability of agro-climate with the help of land resource map and report of Karnataka state, generated at 1 : 2,50,000 scale by ICAR - NBSSLUP, Bangalore. The regions included Bangalore North - GKVK farm and Bangalore North-Rajankunte with Doddaballapur and Hosakote belonging to eastern dry zone of Karnataka, which are endowed with hot moist semi-arid tropical climate at an elevation of 850-900 m above MSL that exclusively produces 52,240 tonnes of *Bangalore blue* grapes from 2,791 ha per year for a long while. Soil profiles were studied at these selected sites. The major *Bangalore blue* grapes-growing soils of Karnataka are generally dark red, deep, non-gravelly and well drained, sandy clay or clayey in texture with moderate, medium and sub-angular blocky structure. Soils were slightly acidic to neutral in reaction and low to medium in soil organic carbon status. Cation exchange capacity and base saturation varied from low or medium and moderate or high, respectively. The major taxa of the soils identified at sub-group level of soil taxonomy are *Rhodic Kandiustalfs, Kandic Paleustalfs, Typic Rhodustalfs* and *Typic Haplustalfs* in the order of soil development. The study along with assessed fertility status could evolve the soil test based application of OM, nitrogenous and K containing fertilizers as a routine mechanism in developing a decision support system for successful cultivation of *Bangalore blue* grapes variety in eastern dry zone of Karnataka.

Keywords : *Bangalore blue* grapes-growing soils, Characterization and classification, Soil fertility

In India, grapes are exclusively grown on a variety of soil types in a total of 1,39,000 ha with an annual production of 29.58 lakh tonnes. The major grapes-growing states can broadly be divided into two groups namely, North Indian states Punjab, Haryana and parts of Uttar Pradesh and South Indian states of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu contribute towards the larger junk of the area under grapes production. North India has comparatively less area (13%) under grapes cultivation. In Karnataka, its cultivation is seen and restricted to 29,110 ha and an annual production of 3.39 lakh tonnes in Krishna valley of northern Karnataka and Nandi valley near Bengaluru. The most commonly grown grapes varieties here are *Thompson seedless, Krishna seedless, Manikchaman, Bangalore blue, Red lobe* and *Anab-e-shahi*. However, *Bangalore Blue* and *Anab-e-shahi* and its local clones are the most popular varieties in Eastern dry zone of Karnataka. *Bangalore Blue* grapes are being cultivated in the state with an area of 2,794 ha with a production of 52,279 tonnes.

Bangalore Blue is a moderate yielder and the vines are medium in vigour. Bunches are medium to small in size and compact. The berries are bluish black or dark purple in colour, seeded; medium in size and spherical in shape, pulp is green and juicy. The juice is purple coloured ; foxy flavoured having Total Soluble Solids (TSS) of about 16 to 18 °Brix and about 0.8 to 1.0 per cent acidity (Winkler *et al*., 1974). It is a mid season variety and ripening of berries is sometimes uneven. It is less preferred for table purpose

as the berries are acidic in nature and thick skinned; however, *Bangalore Blue* grapes are commonly used for juice and wine making. The variety is quite hardy for mildews and other diseases compared to other varieties of grapes. By staggered pruning two crops in a year can be taken.

The superior quality and high productivity obtained in Karnataka is mainly due to the favourable conditions such as climate and soils prevailing in the region. But in recent years, yield of vine yards are declining exponentially (FAO, 2016). The optimum to exploitative utilization of land resources with intensification of crop hasresulted in depletion and mining of nutrients and rarely accumulation. Characterization and classification of major *Bangalore Blue* grapes-growing soils will give an easy and long term solution for identifying the soil related potentials and constraints with detailed information with regard to crop production. Keeping an eye on the importance of land resources information of *Bangalore Blue* grapes cultivation, an attempt was made here to study the land resources with characterization and classification and assessing the inherent fertility of *Bangalore Blue* grapes-growing soils of Karnataka.

Material and Methods

Study Area

The study area was chosen on the basis of area, production and productivity of major *Bangalore Blue* grapes-growing areas of Karnataka (2013 - 2014 and the sampling locations are presented on Table 1.

Table 1
Soil sampling location of major *Bangalore Blue* grape-growing areas of Karnataka

Location	District	Taluk
13° 04' 57.1" N latitude 77° 34' 04.3" E longitude	Bengaluru Urban	Bengaluru North (GKVK farm)
13° 10' 15.0" N latitude 77° 31' 21.0" E longitude	Bengaluru Urban	Bengaluru North (Rajankunte)
13° 17' 12.5" N latitude 77° 28' 30.3" E longitude	Bengaluru Rural	Doddaballapur
13° 10' 50.9" N latitude 77° 49' 30.0" E longitude	Bengaluru Rural	Hoskote

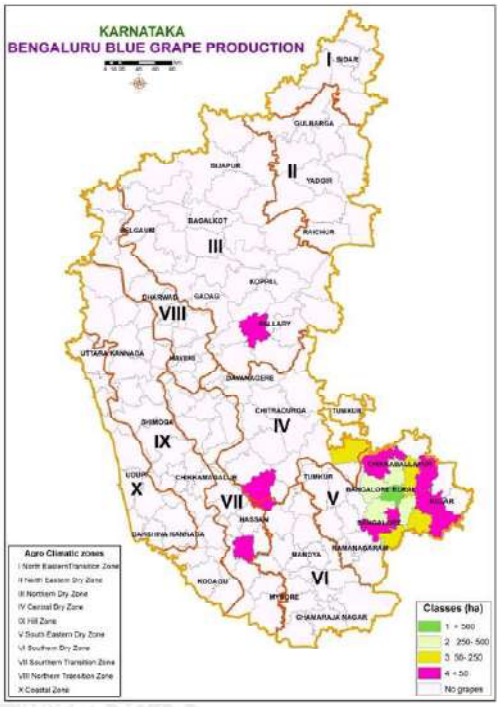

Fig. 1: Concentration per taluka of *Bangalore Blue* grapes-vineyards of Karnataka

Bangalore Blue grapes-growing areas of 2794 ha are mainly confined to Bangalore Rural and Urban and Chikkaballapur districts with a production of 52,279 tonnes and a productivity of 18.71 tonnes per ha, The taluka wise concentration of vineyards of *Bangalore Blue*-growing areas is made in Fig. 1.

The study location falls in hot moist semi-arid climate recording an average rainfall of 782.7 mm (Doddaballapur pedon), 963.2 mm (GKVK farm and Rajankunte pedons) and 808.4 mm (Hoskote pedon). The respective mean annual maximum and minimum temperature are 29.4 and 20.2 °C (GKVK farm and Rajankunte pedons), 31.2 and 19.7 °C (Doddaballapur) and 31.6 and 18.1 °C (Hosakote pedon). Soil samples from all the pedons were collected from horizons for the laboratory analysis to understand physical and chemical properties. Morphological properties of the soils were studied following the procedure explained in Soil Survey Manual (Soil Survey Staff, 2014). Particle-size analyses were done by International Pipette method (Sarma *et al*., 1987). The pH was determined in 1:2.5 soil-water suspension and electrical

conductivity in its supernatant portion (Jackson, 1973). Cation exchange capacity of the soils was determined by the ammonium acetate leaching method (Sarma *et al.*, 1987). Climatic parameters were arrived at using the data recorded by the Indian Meteorological Department for Karnataka from 1966 to 2002.

Results and Discussion

Morphological Characteristics

Relevant soil site morphological characteristics and textural properties are furnished in Table 2 and 3. *Bangalore Blue* grapes-growing soils were deep to very deep with their depths varying from 106 cm to more than 151 cm. The variation in topography and slope gradient have resulted in the variation in depth (Vinay, 2007). Solum depth reflects the balance between soil formation and soil loss by erosion in any area. Doddaballapur soil recorded less depth (106 cm). Among the pedons, the distinctness of soil boundary varied from clear to gradual and topography of smooth boundary.

Soil colour ranged mainly from 2.5 YR to 7.5 YR hues, values from 2.5 to 4 and chromas 4 to 8. Soil colour of pedons in surface varied from dark reddish brown to brown and that of lower horizons registered dark reddish brown to strong brown. This is attributed to the differential degrees of erosion, less content of organic matter and rubrifaction by iron oxide, haematite (Patil and Dasog, 1999). The mineralogical and chemical composition of soil coupled with texture and topographic position resulted in variations in soil colour (Avinash *et al*., 2019). The texture varied from sandy clay to clay among the soils. This might be due to differential processes of soil formation, *in situ* weathering and illuviation of clay (Geetha and Naidu, 2013). The structure varied from weak to moderate, fine to coarse, sub-angular blocky in both surface and sub-surface horizons. Massive structure was observed in the lower most horizon of the Rajankunte and GKVK farm soils indicates the lack of aggregation in the layer. Consistency of soil varied from extremely hard to soft when dry, friable to very firm when moist and non-sticky to very sticky and non-plastic to very plastic when wet. The clay content in a soil influences soil consistency (Sarkar *et al*., 2001) and an increase in clay content increases soil consistency and workability.

Physical and Chemical Characteristics

Physical and chemical characteristics of the pedons are furnished in Table 3. *Bangalore Blue* grapes growing soils of Karnataka recorded a clay content ranging from 16.6 to 51.6 per cent. An increase in clay content along with depth up to certain depth could be observed due to the soil development processes. Illuviation of clay towards the lower surface from the surface soil resulted in increased clay content in the sub-surface horizons (Srinivasan *et al*., 2013). Eluviations of clay in some horizon would have resulted into lower values of clay in subsequent

Table 2

Site characteristics

Pedon No./Name	Elevation (m)	Rainfall (mm)	Physiography	Slope (%)	Drainage	Erosion	Parent material
P1. Bangalore North (GKVK farm)	915	936.2	Undulating upland : Moderately sloping	5-10	Welldrained	Moderate	Granite and laterized granite
P2. Bangalore North (Rajankunte)	891	963.2	Undulating upland : Gently sloping	3-5	Welldrained	Slight	Granite and laterized granite
P3. Doddaballapur	897	782.7	Undulating upland : Very gently sloping	1-3	Welldrained	Slight	Granite and granitic colluvium / alluvium
P4. Hoskote	895	808.4	Undulating upland : Gently sloping	3-5	Welldrained	Moderate	Granite: weathered

TABLE 3
Morphological characteristics

Horizon	Depth (cm)	Boundary	Colour		Texture	Structure	Consistence			Roots	Pores
			Dry	Moist			Dry	Moist	Wet		
P1. Bangalore North (GKVK farm)											
0-13	Ap	c s	5 YR 4/4	5YR 3/4	cl	1F sbk	sh	fr	ms & mp	f c, f	f m, f
13-37	Bt1	c s		5YR 4/4	c	2F sbk		fr	ms & mp	f c, f	c c, m
37-60	Bt2	c s		2.5YR 4/4	c	2F sbk		fr	ms & mp	f f	c f, m
60-78	Bt3	c s		2.5YR 3/4	gc	2F sbk		fr	ms & mp	c f	c m, f
78-104	Bt4C	a s		2.5YR 4/6	c	2F sbk		fr	ms & sp		f m
104-130	Bt5C	c s		2.5YR 4/4	vgc	2F sbk		fr	ms & sp		c m, c
130-151+	BC			2.5YR 4/6	egc	massive		fr	ms & sp		f m
P2. Bangalore North (Rajankunte)											
0-22	Ap	a s	7.5YR 4/3	7.5YR 3/3	gscl	2F sbk	sh	fr	ss &mp	c m	c m
22-44	Bt1	a s	2.5YR 3/4	7.5YR 3/4	vgc	2F sbk	h	fr	ms & sp	f m	f c, m
44-73	Bt2	c s	2.5YR 3/6	7.5YR 3/6	gc	2M sbk	h	fr	ms & ps	f m	c f
73-101	Bt3	c s	2.5YR 4/6	7.5YR 4/6	sc	2M sbk	sh	fr	ss & ps	f f	c m
101-123	BC	c s		7.5YR 5/8	sl	1M sbk	s	fr	s0 & p0	f m	f m
123-134+	CB			5YR 3/4	sil	massive		fr	ss & ps		f m
P3. Doddaballapur											
0-11	Ap	c s	7.5YR 3/3	7.5YR 2.5/3	sc	2F sbk	vh	fr	s & mp	c vf	c f
11-27	Bt1	a s	5YR 3/4	5YR 3/4	sc	2F sbk	vh	fr	s & ps	c m	f f
27-41	Bt2	c s		5YR 4/4	sc	2M sbk		fr	ss & ps	f m	c m
41-74	BC1	c s		7.5YR 3/4	c	1M sbk		fr	vs & p		c m
74-106	BC2	c s		7.5YR 4/4	c	1M sbk		fr	vs & p		f m
106-151+	BC3			7.5YR 4/6	c	1M sbk		fr	vs & vp		f m
P4. Hoskote											
0-20	Ap	c s	5YR 5/4	5YR 4/4	cl	2F sbk	vh	fr	s & vp	f f	c f
20-39	Bt1	c s		5YR 4/4	c	2F sbk	eh	fr	s & mp	f m	c f, m
39-57	Bt2	c s		2.5YR 4/4	c	2M sbk		fr	s & vp	f m	c m
57-83	Bt3	c s		2.5YR 4/6	c	2M sbk		vfi	s & vp	f f	
83-112	Bt4	c s		2.5YR 4/6	c	2M sbk		fi	s & vp	f vf, m	
112-151	Bt5C			2.5YR 4/6	c	1M sbk		fr	s & mp		
106-151+	BC3			7.5YR 4/6	c	1M sbk		fr	vs & vp		f m

horizons. Illuviation process has also contributed to the depth-wise distribution of sand and silt contents. Silt content ranged from 2.7 - 26.8 per cent and that of sand content varied from 25.9 to 62.5 per cent. The trend of sand and silt distribution with depth was irregular due to the differences in period of weathering and moisture saturation of granite and laterized granitic parent material carbon content at the surface. Lower BD values in certain horizons might be due to varied levels of sand, silt, clay and organic carbon and or gravel, pore space and aggregation of particles (Avinash *et al*., 2019).

The pH in soil water suspension ranged from 6.06 to 6.98. The soil reaction varied from slightly acid to neutral among the soils due to the accumulation of basic salts from weathered parent material. The surface horizons was found to be acidic than subsurface horizons, which might be due to release of organic acids by the decomposition of organic

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matter added in the surface layer and the presence of acidic parent material such as granite and laterized granite. The results corroborate the findings of Vaidya *et al*. (2014) in the soil pedons of pomegranate-growing areas.

Electrical conductivity ranged from 0.05 to 0.36 dS m^{-1}, which indicated non-saline nature of soils. This could also be an indication of good status of cations and anions that are important in grape nutrition (Nair *et al*., 2018). The organic carbon content ranged from 0.03 to 0.57 per cent. The Rajankunte pedon recorded higher OC content in surface layer. Over all surface soils recorded higher organic carbon content than sub-surface horizons due to an increased amount of litter and crop residues at the surface and faster rates of its decomposition. Organic carbon content decreased with depth in all the pedons studied (Avinash *et al.*, 2019).

Cation exchange capacity varied both location-wise and depth-wise. Cation exchange capacity of soils varied from 5.17 to 29.37 cmol (p^+) kg^{-1} of soil. All the pedons recorded lower CEC values (<16 cmol (p^+) kg^{-1} of soil) in surface layer except for the Doddaballapur pedon which recorded higher CEC in lower horizons (16.83-29.37 cmol (p^+) kg^{-1} of soil) which might be due illuviation of clay from surface to subsequent sub-surface horizons. Low CEC values even with high clay content indicate the dominance of low activity clays particularly; 1:1 type clay minerals (Avinash *et al.*, 2019). Higher CEC values were observed in surface horizons due to higher organic matter at the surface. CEC / clay ratio varied from 0.12 to 1.38, which indicated nature of clay minerals in different pedons. The soils of all pedons had sub-active to semi-active clays whereas, Doddaballapur pedon recorded sub-active to super-active clays. Lower CEC / clay ratio indicated the presence of kaolinitic clays and the super-active clays indicate dominance of smectitic clays. The base saturation ranged from 23.42 to 86.35 per cent. Soils were highly base saturated in all the layers except GKVK farm pedon, which recorded moderate base saturation at Bt4C and Bt5C horizon and the immediate BC horizon recorded very high base saturation of 54.24 per cent. Percolating water takes bases along with it, from top horizon to lower horizons resulting in increased base saturation with the depth (Rita *et al*., 2020).

Soil Classification

Based on the internationally accepted system of soil classification, Soil Taxonomy (USDA), the studied soils were classified which is presented in Table 4.

Pedon 1 (Bengaluru North - GKVK Farm) (Fine, Kaolinitic, Sub-Active, ISO - Hyperthermic *Rhodic Kandiustalfs*)

Pedon 1 (Bangalore North - GKVK Farm) is having clay translocated argillic sub- surface horizons and do not have oxic, plaggen and spodic epipedon or sub-surface horizons above the clay trans located horizon, further more the argillic horizons have the base saturation by sum of cations of more than 35 per cent. So pedon 1 is keyed out as *Alfisols* at order level. At sub-order level, all pedons are coming under moisture regime ustic, hence these pedon is classified as *ustalfs*. Pedon 1, within that kandic horizon upper 75 cm or throughout the entire kandic horizon (if <75 cm thick) or more than 50 per cent of the colours that is having hue of 2.5YR or redder, value of moist soil three or less and dry value no more than one unit higher than the moist value, so upto sub group level this pedon has been classified as *Rhodic Kandiustalfs*. At the family level the soil texture is fine (>35% clay) with kaolinitic mineralogy, sub-active at cation exchange activity classes because the ratio of CEC to per cent clay (by weight) was less than 0.24 and iso-hyper thermic temperature regime (Characterized by MAT of >22 °C with MAST and MWST differ by less than 6 °C) was noticed.

Pedon 2 (Bangalore North - Rajankunte) (Fine, Mixed, Semi-Active, ISO-Hyperthermic *Typic Rhodustalfs*)

The soil sampled at Bengaluru North - Rajankunte (Pedon 2) representing Eastern dry zone is classified

TABLE 4

Physical and chemical properties

Horizon	Depth (cm)	Sand	Silt	Clay	BD Mg m^{-3}	pH	EC dS m^{-3}	OC (%)	Base saturation (%)	CEC cmol kg^{-1}	CEC/Clay Ratio
		(%)									
P1. Bangalore North (GKVK farm) (Fine, kaolinitic, sub-active, iso-hyperthermic *Rhodic Kandiustalfs*)											
0-13	Ap	37.7	23.0	39.3	1.37	6.21	0.14	0.51	80.08	12.76	0.32
13-37	Bt1	34.1	20.6	45.3	1.33	6.34	0.05	0.30	44.98	8.69	0.19
37-60	Bt2	34.5	17.6	47.9	1.37	6.37	0.05	0.26	63.66	8.14	0.17
60-78	Bt3	36.6	18.5	44.9	1.34	6.24	0.06	0.21	82.87	7.48	0.17
78-104	Bt4C	35.0	19.5	45.5	1.49	6.04	0.08	0.18	23.58	6.60	0.15
104-130	Bt5C	34.9	21.6	43.5	1.55	6.06	0.08	0.12	23.42	5.94	0.14
130-151+	BC	37.7	17.4	44.9	1.54	6.07	0.09	0.06	54.24	5.17	0.12
P2. Bangalore North-Rajankunte (Fine, mixed, semi-active, iso-hyperthermic *Typic Rhodustalfs*)											
0-22	Ap	62.5	9.7	27.8	1.58	6.71	0.10	0.57	43.70	15.84	0.57
22-44	Bt1	38.4	15.3	46.3	1.35	6.81	0.13	0.36	50.37	19.14	0.41
44-73	Bt2	27.0	23.7	49.3	1.35	6.78	0.34	0.21	48.15	16.83	0.34
73-101	Bt3	46.2	12.2	41.6	1.39	6.86	0.36	0.15	56.52	23.43	0.56
101-123	BC	54.4	29.0	16.6	1.56	6.94	0.34	0.09	57.43	22.99	1.38
123-134+	CB	23.6	50.8	25.6	1.56	6.98	0.36	0.06	62.86	29.37	1.15
P3. Doddaballapur (Fine, mixed, semi-active, iso-hyperthermic *Typic Haplustalfs*)											
0-11	Ap	49.6	10.5	39.9	1.64	6.72	0.08	0.48	68.32	11.88	0.30
11-27	Bt1	54.4	8.8	36.8	1.55	6.91	0.08	0.36	56.39	11.22	0.30
27-41	Bt2	55.8	2.7	41.5	1.52	6.93	0.07	0.21	51.96	7.15	0.17
41-74	BC1	43.2	7.9	48.9	1.47	6.93	0.12	0.21	69.31	12.98	0.27
74-106	BC2	45.0	9.2	45.8	1.64	6.92	0.13	0.12	43.59	10.56	0.23
106-151+	BC3	39.1	11.7	49.2	1.47	6.94	0.12	0.03	49.07	12.32	0.25
P4. Hoskote (Fine, kaolinitic, sub-active, iso-hyperthermic *Kandic Paleustalfs*)											
0-20	Ap	40.4	22.4	37.2	1.64	6.43	0.07	0.45	44.89	8.14	0.22
20-39	Bt1	42.4	12.8	44.8	1.55	6.29	0.12	0.33	41.02	8.58	0.19
39-57	Bt2	37.1	11.3	51.6	1.52	6.24	0.15	0.24	46.43	8.14	0.16
57-83	Bt3	25.9	25.6	48.5	1.47	6.41	0.18	0.21	86.35	8.25	0.17
83-112	Bt4	27.6	26.8	45.6	1.64	6.66	0.20	0.11	72.92	8.80	0.19
112-151	Bt5C	35.8	18.3	45.9	1.55	6.85	0.23	0.03	52.97	9.02	0.20
106-151+	BC3	39.1	11.7	49.2	1.47	6.94	0.12	0.03	49.07	12.32	0.25

under *Alfisols* with argillic sub-surface horizon and this is keyed out as *Rhodustalfs* at great group level as they have within upper 100 cm or the entire argillic horizon more than 50 per cent 2.5YR or redder and values (moist) ≤ 3 and dry values are not more than one unit higher than moist values. At the family level the soil texture is fine (>35 % clay) with mixed mineralogy, semi-active at cation exchange activity classes because of theratio of CEC to per cent clay (by weight) was between 0.24 and 0.40 and with iso-hyperthermic temperature regime.

Pedon 3 (Doddaballapur) (Fine, Mixed, Semi-Active, ISO-Hyperthermic *Typic Haplustalfs*)

The soil studied at Doddaballapur (Pedon 3) is classified under *Alfisols* and do not meet the requirements of all other great groups of the sub-order level, so keyed as *Haplustalfs*. It is upholding the central characteristics of that sub-group therefore is classified as *Typic Haplustalfs*. At the family level the soil texture

TABLE 5
Soil Fertility status of area studied

Depth (cm)	Horizon	OC (%)	Primary Nutrient status (Kg ha^{-1})		
			Available N	Available P_2O_5	Available K_2O
P1. Bangalore North (GKVK farm)					
0-13	Ap	0.51	203.8	547.62	126.56
13-37	Bt1	0.30	188.2	129.27	105.28
37-60	Bt2	0.26	156.8	18.54	162.40
60-78	Bt3	0.21	78.4	10.91	187.04
78-104	Bt4C	0.18	62.7	6.00	221.76
104-130	Bt5C	0.12	31.4	13.64	267.68
130-151+	BC	0.06	0.00	20.73	264.32
P2. Bangalore North (Rajankunte)					
0-22	Ap	0.57	345.0	664.89	398.72
22-44	Bt1	0.36	141.1	51.82	551.04
44-73	Bt2	0.21	78.4	8.73	171.36
73-101	Bt3	0.15	47.0	6.55	40.32
101-123	BC	0.09	15.7	10.91	36.96
123-134+	CB	0.06	6.3	25.09	33.60
P3. Doddaballapur					
0-11	Ap	0.48	188.2	348.54	249.76
11-27	Bt1	0.36	94.1	100.91	85.12
27-41	Bt2	0.21	172.5	31.09	36.96
41-74	BC1	0.21	125.4	8.18	47.04
74-106	BC2	0.12	62.7	4.36	52.64
106-151+	BC3	0.03	109.8	7.64	54.88
P4. Hosakote					
0-20	Ap	0.45	188.2	195.27	170.24
20-39	Bt1	0.33	94.1	57.27	59.36
39-57	Bt2	0.24	94.1	12.55	34.72
57-83	Bt3	0.21	78.4	18.54	30.24
83-112	Bt4	0.11	62.7	9.82	16.80
112-151	Bt5C	0.03	15.7	19.64	6.72

is fine (>35 % clay) with mixed mineralogy, semi-active at cation exchange activity classes because the ratio of CEC to per cent clay (by weight) was between 0.24 and 0.40 with iso-hyperthermic temperature regime.

Pedon 4 (Hoskote) (Fine, kaolinitic, Sub-Active, ISO-Hyperthermic *Kandic Paleustalfs*)

Pedon 4 (Hoskote) showed clay translocated argillic sub-surface horizons and do not have oxic, plaggen and spodic epipedon or sub-surface

horizons above the clay translocated horizon, further more the argillic horizons have the base saturation by sum of cations of more than 35 per cent. So pedon 4 is keyed out as *Alfisols* in order level. At sub-order level, the pedonis coming under moisture regime ustic, hence these pedons were classified as *ustalfs*. Pedon 4 is having CEC of less than 24 cmol (p^+) kg^{-1} clay (by 1N NH_4OAc pH 7) in 50 per cent or more of the argillic horizon upper 100 cm, therefore, it is being classified as *Kandic Paleustalfs*. At the family level the soil texture is fine (>35 % clay) with kaolinitic mineralogy, sub-active at cation exchange activity classes due to ratio of CEC to per cent clay (by weight) was below 0.24 and prevailing iso-hyperthermic temperatureregime.

Fertility Status

Organic carbon was medium and ranged from 0.45 - 0.51 per cent in surface and that of sub-surface horizons it was low and ranged from 0.03 - 0.36 per cent. The higher organic carbon content in surface might be due to addition of organic manures in surface layer. Available nitrogen in surface was found to be low (188.2 to 203.8 kg ha^{-1}), except for the Bengaluru North - Rajankunte pedon, which recorded medium fertility status of N with a value of 345 kg ha^{-1}. The lower nitrogen content might be due to faster mineralization assisted by high temperature (Dry zone) and loss of nitrogen in the form of ammonia. Lower horizons below Ap horizons were found to be low in available nitrogen content. The Bt2 and BC1 horizons of Doddaballapur pedon have recorded higher N (172.5 and 125.4 kg ha^{-1}, respectively) compared to Bt1 horizon (94.1 kg ha^{-1}), which might be due to faster leaching of nitrate ions into these deep layers. Available P_2O_5 was very high and ranged from 195.27 to 664.89 kg ha^{-1} in surface and sub-surface horizons it was medium or high and ranged from 6.0 to 129.27 kg ha^{-1}. The lower mobility of P, lateritic parent material and regular application of phosphatic fertilizers might have resulted into higher content of P in surface than that of lower layers. The available K in surface soils was found to be low (126.56 kg ha^{-1}) in Bengaluru North - GKVK Farm pedon and high (398.72 kg ha^{-1}) in Bangalore North - Rajankunte pedon, while it was quite interesting fact to note that highest K (551.04 kg ha^{-1}) was recorded at Bt1 horizon of Bangalore North - Rajankunte soils. The higher K content than that of Ap horizon might be attributed to leaching of potassium ions from surface to sub-surface layer. The K mining by vines was observed in all grapes-growing soils in general in all the pedons studied (Ikhe *et al*., 2017) and seepage loss and luxury consumption also adding to this.

Bangalore Blue grapes-growing soils of Karnataka are fine, red, well drained and well aggregated and have an argillic or kandic sub-surface horizon. Further, clay illuviation has resulted in the development of low CEC, medium base saturated argillic or kandic horizon The base saturation was more than 35 per cent throughout the depth of the horizon and were classified under *Kandiustalfs*, *Paleustalfs*, *Rhodustalfs and Haplustalfs* in the order of deviation from soil development. *Bangalore Blue* grapes-growing soils of Karnataka were deep, dark red brown to strong brown, slightly acid with kaolinitc or mixed mineralogy, showing dominance of low active clays.

The USDA soil taxonomy and the family level classification followed in this study has helped in reflecting the soil properties and their variability among the different locations of *Bangalore Blue* grapes-growing soils of Karnataka depicting the great potentials with regard to climate, landform, soils and their inherent fertility and listing the possible constraints for management.

The fertility status for OC in soil varied from low to medium, nitrogen ranged from low to medium, P accumulation was found in surface layer and potassium content showed high variation. The application of nitrogen and potassium containing materials such as fertilizers and organic manure would cop up with the nutrient deficiency especially pertaining to primary nutrient elements existing in these soils and finally to obtain a quality produce.

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