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Affect of application of black soils over a native red soils on soil physical and physico-chemical properties

Rajeshwar Malavath and S Mani

Abstract
Field wise geo-referenced morphological, physico-chemical characteristics and nutrients status by application of applied black soils over native red soils of semi arid regions of Tamil Nadu, India were studied. The physiography of study area was nearly level to gently sloppy. The textural class of fine earth fraction was coarse textured gravelly sandy loam and sandy clay loam in the surface soils of native red soils and sandy clay loam in sub-surface horizons of applied black soils over native red soils, whereas clayey in surface layers of applied black soils. The clay content was ranged from17.4 to 19.6 percent in surface and 19.8 to 21.4 percent in subsurface soils of native soils. The sub surface horizons of applied black soils over native soils, clay content ranged from 21.1 to 25.8 percent. The surface soils exhibited weak medium fine granular structures in native soils whereas in subsurface soils of applied black soils over native soil shown weak to medium subangular blocky structures. The moisture retention at field capacity (33kpa) by application of applied black soils over native red soils varied from 29.2-30.4 and 19.8-22.7%, permanent wilting capacity (1500kpa) varied from 14.8-16.9 and 7.6-9.2%, available water capacity varied from 13.6-15.5 and 11.9-14.1% respectively in both the surface and sub surface soils. The moisture retention at field capacity varied from 16.2-19.4 and 16.2-18.5%, at permanent wilting capacity varied from 5.4-7.6 and 4.9-7.8% and the available water capacity varied from 10.2-11.6 and11.3-11.9% in both the surface and sub surface soils of native red soils respectively. The moisture retention at field capacity, permanent wilting point and available water capacity were high in sub surface soils of application of black soils over the native red soils at different soil water suctions than native surface and subsurface soils. Exchangeable bases in all the soils were in the order of $Ca^{++}>Mg^{++}>Na^{+}>K^{+}$ on the exchangeable complex. The $CaCO_3$ content of native red soils (5.5 to 7.8 and 6.0 to 9.0 g kg^{-1}) and in applied black soils ranged from 21.0 to 42.0 and 6.5 to 11.8 g kg^{-1} in both the surface and sub surface soils respectively.

Keywords: Application of black soils over native soils, morphological, physico-chemical characteristics

Introduction
Tamil Nadu being under a semi-arid tropical monsoon climate has a number of soil types which are found in all types of climates, occupying for 4.0 percent (12.99m.ha) of the country's geographical area. Hence their management varies from place to place besides the crop variation effect. Maintaining soil in the state of high productivity on sustainable basis is important for meeting basic needs of the people. Systematic study of soils is important for scientific utilization of land resources for sustainable agriculture production.

The black soils are made up of extremely fine clayey material. They are well known for their capacity to hold moisture. In addition, they are rich in soil nutrients, such as calcium carbonate, magnesium, potash and lime. They develop deep cracks during hot weather, which helps in the proper aeration of the soil. It is mainly applied to improve soil and moisture conservation, water holding capacity as well as increase the aeration and porosity of the soil for better root growth. The information available on the application of applied black soils over native red soil is meager.

Knowledge of the application of black soils over native soils is necessary for proper appraisal of their productivity and potential use. Keeping this in view, field wise geo-referenced morphological, physical, physico-chemical characteristics and nutrients status by application of applied black soils over native red soils and native red soils was taken upfor better scientific utilization of lands by identifying the potentials and limitations and to suggest suitable crop plan and management options for higher productivity.

Materials and Methods

Location and site characteristic of study area

Dindigul District is located between 1˚05' and 1˚09' North Latitude and 77˚30' and 78˚20' East Longitude. It is bounded by Erode, Karur and Trichirapalli districts on the North, Madurai district on the East and South and Coimbatore district and Kerala State on the West. A Maize Research Station has been set up by Tamil Nadu Agriculture University (TNAU) on 16-03-2007 at Vagarai village, Dindigul district with its main objectives for the developing hybrid maize and new technologies and imparting advanced training to maize growers and conducting joint research programmes with international maize research organizations. The Research Station is extending over an area of 22.94 acres and boundary is surrounded between 10.570' N latitude and 77.56' E longitudes and is situated at an altitude of 254.45 m above Mean Sea Level (Fig.1). The physiography of study area was nearly level to gently sloppy in nature. The Research Station has total number of 13 fields. Among that 9 numbers of fields such as A2, A3, A4, A5, A6, B3, B4, B5 and B6 are fully filled with applied black soils at the rate of 390 tones ha^{-1}over native red soils at an average depth of 20 cm during the year 2007. Thus the upper 20 cm depth of soils became applied black soil layer and native red soil became subsurface layer. The applied black soils have more than 65% clay and silt particles. It is mainly applied for improving soil moisture conservation and water holding capacity for better root growth and crop establishment.

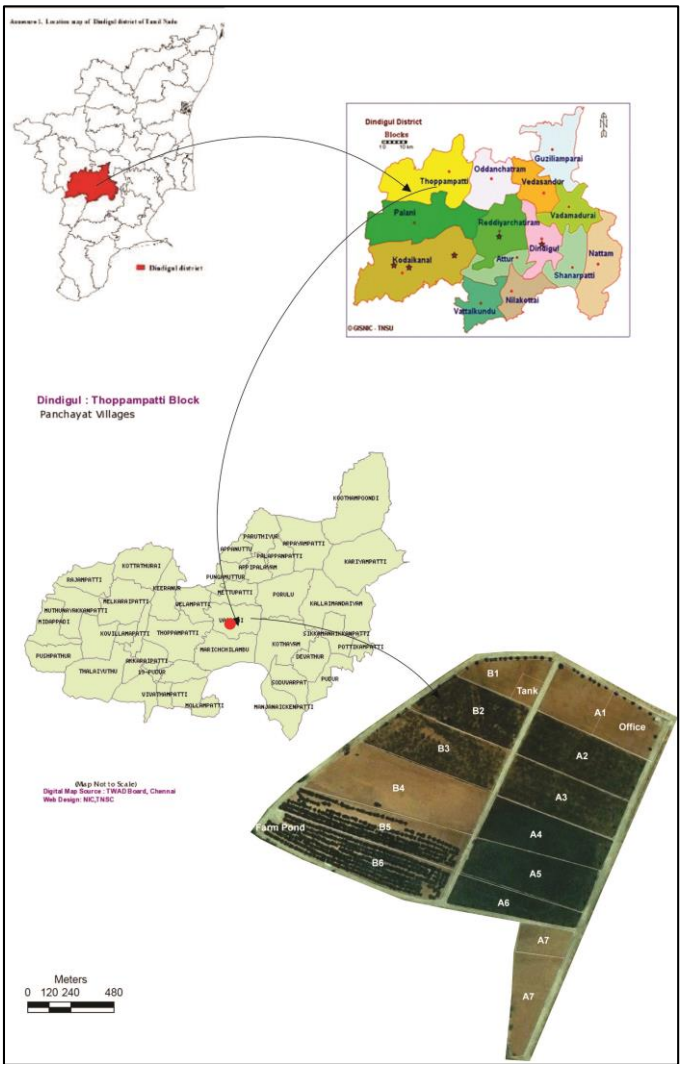

Fig 1: Maize Research Station, Vagarai

The weather is pleasant during the period from November to January and the lowest mean daily temperature is 17.0º C. The temperature begins to rise after March, the period from April to June is generally hot and dry with the maximum temperature is 36.0ºC. Usually mornings are more humid than afternoons. The relative humidity varies between 65 and 85% in the mornings while in the afternoon it varies between 40 and 70%. The mean annual rainfall of the study area is 700 mm**.** The north east monsoon contributes 45% of the annual rainfall from October to December. South west monsoon also contribute 37% of rainfall from July to October. The soil moisture control section is dry for more than 90 cumulative days or 45 consecutive days in the months of summer solstice. The soil moisture and soil temperature regimes of the study area are ustic and isohyperthermic, respectively. The natural vegetation includes grasses *Cynodon dactylon, Cyprus rotundus, Azadirata indica, Prosopis juliflora, cacia*sps,. *Prosopis juliflora*, mango (*Manjifera indica*), *Tamarindus indica*, broad leaf weeds such as *Selotia, Parthenium, Euforbia* sps, etc. The main source of irrigation is from bore well and rainfall in the monsoon season. The principal crops cultivated and Research focused mainly on maize.

In order to delineate the detailed field wise morphological, physical and physico-chemical characteristics by application of applied black soils over native red soils,13 surface (0-15 cm) and 13 sub-surface (15-30 cm) soil samples were collected from each fields of two different blocks of research station. The soil samples were air-dried in shade, processed and screened through a 2mm sieve and analyzed by using standard procedures. The detailed morphological description of surface and subsurface soils was made as per the procedure outlined in Soil Survey Manual (Soil Survey Staff. 1951). Particle size analysis was done according to International Pipette method (Piper. 1966) [6], bulk density (Blake and Hartze, 1986) [1] and water holding capacity (Sankaram, 1966) [7]. The field capacity and permanent wilting points were determined at 1/3 bar (33kPa) and 15 bar (1500kPa) respectively in Pressure Membrane Apparatus (Model: Lab0123. Make: Soil Moisture Equipment Corp., USA) available in the Department of Soil Science and Agricultural Chemistry, TNAU, Coimbatore. The soil samples were water soaked overnight in their respective porus plates and equilibrated for field capacity at 1/3 bar and permanent wilting point at 15 bar pressure. The moisture content of equilibrated soil samples were determined by oven dry method. The data were statistically analysed through correlation. The soil pH, EC andexchangeable cations as per standard procedure (Jackson. 1973) [4], cation exchange capacity (Chapman, 1965) [2], organic carbon and free calcium carbonate procedure according to Walkly and black, 1934 and Piper, 1966 [6] respectively.

Results and discussions

Soil Morphology

Morphological characteristics of the surface and sub surface soils are described in table 1. The soil color vary from dark red to yellowish red (2.5 YR3/6 to 5 YR5/8),dark reddish brown to yellowish red(2.5 YR3/3 to 5 YR5/6) in dry condition and dark reddish brown to yellowish red (5 YR3/4 to 5 YR5/6 and 5 YR3/2 to 5 YR4/6) in moist condition for both the native surface and subsurface soils respectively might be due to the mineral hematite was associated with 2.5YR and 5YR colours. Free iron oxides played an important role in imparting red color to soil. In case of applied black soils over native red soils color is dark brown (10 YR3/3) in

surface soils and reddish brown to yellowish red (5 YR4/4 to 5 YR5/6) in subsurface soils in dry condition and very dark gray (10YR3/2) in surface soils and very dark grayish brown to dark yellowish brown (5 YR4/4 to 5 YR4/6) in subsurface soils in moist condition. The black soils had colours in the hue 10YR might be due to the presence of iron sulphide and manganese oxide in combination with the organic complex would induce dark colour in black soils (Murthy *et al*., 1982) [5]. The native soils fields had shown medium granular and weak subangular blocky structure in surface and subsurface soils. Applied black soils over native red soils had strong subangular blocky structure in upper 15 cm and medium moderate subangular blocky structure in subsurface soils. When compared to subsurface layers of native soils, the applied black soils over native subsurface soils have subangular blocky structure might be due to presence high $CaCO_3$ in applied black soils which may leads the flocculation of soil particles (Fig.2).The native soils are sandy loam in texture and the applied black soils have clayey in texture and sandy loam to sandy clay loam in subsurface soils might be due to the mobilization and translocation of clay and silt particles moved to the lower depth by frequent ploughing and illuviation. The native soils are loose when they are dry, friable in moist condition; slightly sticky when wet and slightly hard in dry condition and wet they become slightly sticky for both the surface and subsurface soils respectively. The applied black soils are hard when they are dry, firm in moist condition, sticky and plastic when wet. The subsurface soils of applied black soilsare slightly hard when they are dry, friable to firm in moist condition, slightly stickyto sticky when wet might be due to transportation of clay particles in subsurface layers.

Table 1: Morphological characteristics of Surface and sub surface soils of M.R.S, Vagarai

Field	Depth (cm)	Colour		Texture	Structure	Consistency			Effervescence	Pores	Roots
		Dry	Moist			Dry	Moist	Wet			
Native red soils											
A1	0-15	5YR5/8	5YR5/6	sl	m1gr	l	fr	ss	m	f f	c f
	15-30	2.5YR5/6	5YR4/6	scl	m1sbk	sh	fr	ss	m	f f	f f
A7- A9	0-15	2.5YR4/6	5YR3/6	sl	m1gr	l	fi	ss	ms	f f	c f
	15-30	2.5YR4/6	5YR3/6	scl	m2gr	sh	fr	ss	m	f f	f f
B1	0-15	5YR5/6	5YR4/6	sl	m1gr	l	fr	ss	ms	f f	c f
	15-30	5YR4/6	5YR4/6	sl	m1sbk	sh	fr	ss	m	f f	f f
B2	0-15	2.5YR3/6	5YR3/4	sl	m2gr	l	fr	ss	ms	f f	c f
	15-30	2.5YR3/3	5YR3/2	scl	m1sbk	sh	fr	ss	m	f f	f f
Applied black soils over native red soils											
A2	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	2.5YR5/6	5YR4/6	scl	m2sbk	sh	fr	ss	m	f f	f f
A3	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	m	f f	c f
	15-30	2.5YR4/6	5YR3/6	scl	m2sbk	l	fi	so	m	f f	f f
A4	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	2.5YR3/6	5YR3/4	scl	m1 sbk	l	fr	ss	m	f f	f f
A5	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	5YR4/6	5YR4/6	scl	m2sbk	sh	fr	ss	m	f f	f f
A6	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	5YR5/6	5YR4/6	scl	m2sbk	sh	fr	ss	m	f f	f f
B3	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	5YR5/6	5YR4/6	scl	m2sbk	sh	fr	ss	m	f f	f f
B4	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	ms	f f	c f
	15-30	5YR5/6	5YR4/6	scl	m2sbk	sh	fr	ss	m	f f	f f
B5	0-15	10YR3/3	10YR3/2	c	m2sbk	h	fi	s&p	ms	f f	c f
	15-30	5YR5/6	5YR4/6	scl	m1sbk	sh	fr	ss	m	f f	f f
B6	0-15	10YR3/3	10YR3/2	c	m3sbk	h	fi	s&p	m	f f	c f
	15-30	5YR4/4	5YR4/6	scl	m2sbk	sh	fr	ss	ms	f f	f f

Soil texture	:	Ls – loamy sand, Scl –Sandy clay loam, Sc- Sandy clay, Cl- clay loam and C- clay
Soil Structure	:	C-Coarse, M- medium, F- fine, 1- weak, 2- moderate,3 - strong, gr- granular, abk- angular blocky, sbk- sub-angular blocky
Soil Consistence	:	l- loose, sh- slightly hard, h- hard, vh- very hard, vfr-very friable, fr- friable, fi- firm, vf- very firm, so – non sticky, ss –slightly sticky, s- sticky,vs- very sticky, po- non plastic, ps – slightly plastic, p-plastic, vp- very plastic
Pores	:	Size f-fine, m-medium, c-coarse; Quantity f-few, c-common, m-many
Roots	:	Size f-fine, m-medium, c-coarse; Quantity f-few, c-common, m-many
Effervescence	:	m-mild, ms-moderately strong s-strong vs-very strong

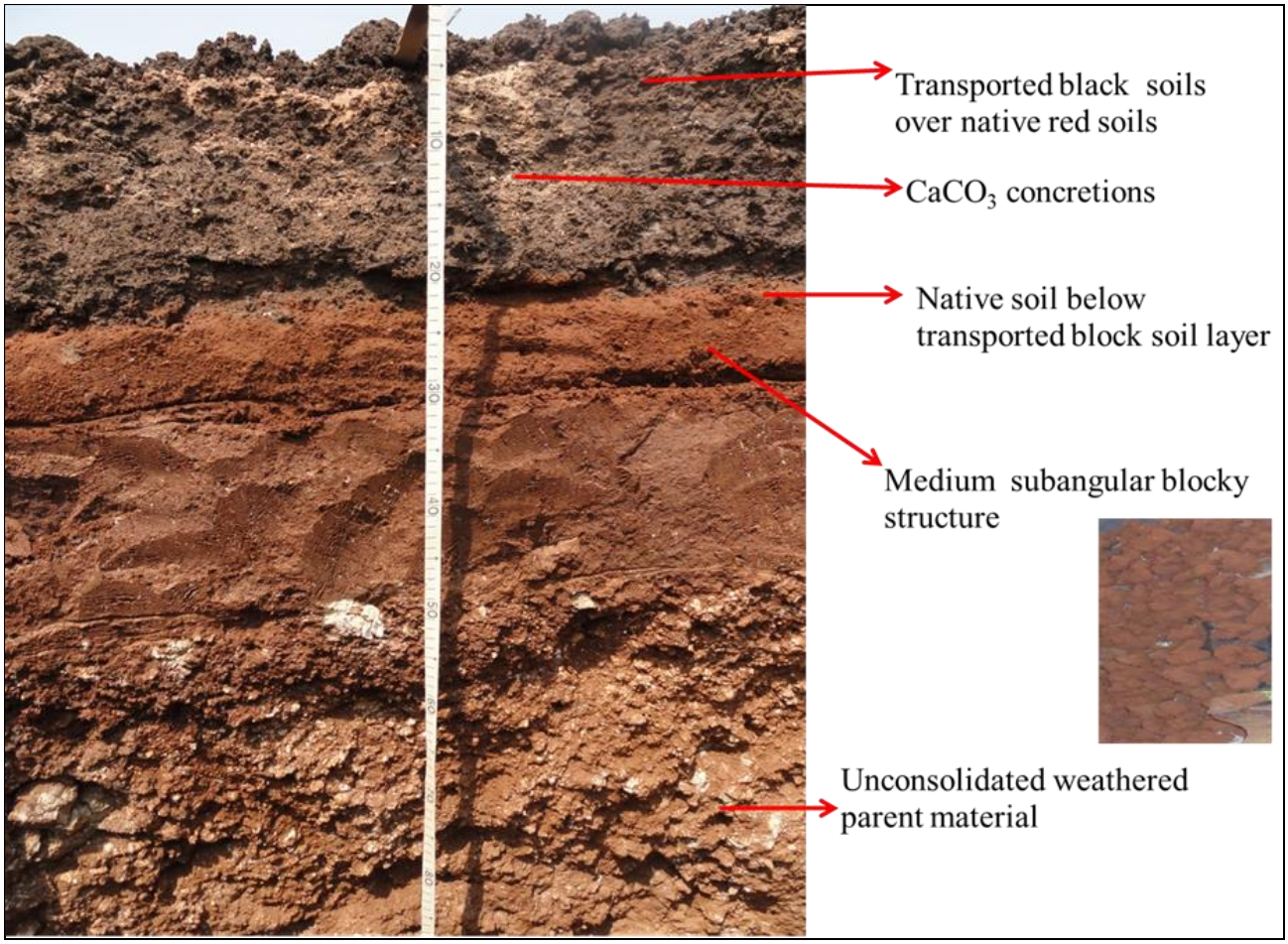

Fig 2: Transported black soils over native red soils (10.5678 ^{0}N, 77.56141 ^{0}E)

Soil Characteristics:

Physical characteristics

Physical characteristics of soil are presented in table 2.The sand, silt and clay content of native soils ranges from 65.2to69.2, 12.5 to15.2 and 17.4 to19.6% and 66.0 to 66.5, 12.6 to14.2 and 19.8 to21.4%in surface soils and subsurface soils respectively. Applied black soils over native red soils had sand, silt and clay content ranges from 30.8 to 35.6, 17.8 to 19.8 and 44.5 to 50.9% and 58.6 to 64.4, 14.2 to 15.9 and 21.1 to 25.8% in surface soils and subsurface soils respectively. The clay content was found to be more in subsurface soils of applied black soils fields than native subsurface soils might be due to the mobilization, translocation and downward movement of clay particles to the lower depth by the frequent ploughing and leaching due to rainfall and irrigation. The gravel content of native soils ranges from 19.8 to 58.4% and 21.3 to 58.5% in surface soils and subsurface soils respectively. The gravel content ranges from 11.3 to 14.5% and 20.7 to 47.3% in surface soils and subsurface soils in application of applied black soils over native red soils. The bulk density values in native red soils ranged from 1.43 to1.44 Mgm^{-3} and1.47 to1.51 Mgm^{-3}both the surface and subsurface soils. In applied black soils over native red soils bulk density values ranged from 1.45to 1.50 Mgm^{-3} and 1.47 to1.51Mgm^{-3} in both the surface and subsurface soils. Lower bulk density values of surface soils might be due to loose and porous nature and organic matter content (Walia and Rao, 1997) [10]. The pores pace of native soils varied from 42.8 to 44.0% in surface and 40.9 to 44.8% in subsurface soils respectively. Applied black soils over native red soils, the porespace varied from 31.9 to 36.5% and 37.8 to 40.1% in surface and subsurface soils respectively.

Water retention Characteristics of application of applied black soils over the native Red soils and native red soils

The moisture retention at field capacity (33kpa) varied from 29.2-30.4 and 19.8-22.7%and at permanent wilting capacity (1500kpa) varied from 14.8-16.9 and 7.6-9.2%respectively in both the surface and sub surface soils. The available water capacity varied from 13.6-15.5 and 11.9-14.1%. The maximum water holding capacity of surface and sub surface soil ranged from 47.48-50.36% and 32.5-36.5% respectively. The surface soils have the more available water capacity than subsurface soil owed to addition of clay containing applied black soils. The moisture retention at field capacity (33kpa) varied from 16.2-19.4 and 16.2-18.5%and at permanent wilting capacity (1500kpa) varied from 5.4-7.6 and 4.9-7.8%respectively in both the surface and sub surface soils. The available water capacity varied from 10.2-11.6 and11.3-11.9%. The maximum water holding capacity of surface and sub surface soil ranged from 28.24-29.94% and 31.1-31.7% respectively. The result reveals that the subsurface soils of applied black soils over native soils have high moisture retention capacity than native subsurface soils due to high deposition black soils as top layer leads the translocation of clay in lower depth which is having high clay content. The higher bulk density and moisture retention at field capacity, at permanent wilting point and available water capacity were more in application of applied black soils over native red soils (Table. 3) which may be due to high smectite clay content, more CEC and more exchangeable cations (Hirekurubar *et al*., 1991) [3].

Table 2: Physical characteristics of surface and sub surface soils of M.R.S, Vagarai

Field	Depth (cm)	Gravel (%)	Particle size distribution (%)					B.D ($Mg\ m^{-3}$)	Pore space (%)	Water retention ($kg\ kg^{-1}$)		AWC (%)	MWHC (%)
			Coarse sand	Fine sand	Total sand	Silt	Clay			33 kpa	1500 kpa		
Native red soils													
A1	0-15	19.8	40.2	25.0	65.2	15.2	19.6	1.43	44.0	17.8	7.6	10.2	28.8
	15-30	21.3	43.6	22.4	66.0	12.6	21.4	1.49	44.8	19.4	7.8	11.6	31.2
A7- A9	0-15	58.4	47.4	21.8	69.2	12.5	18.3	1.47	42.0	16.2	5.4	10.8	28.2
	15-30	58.5	44.5	22.0	66.5	13.2	20.3	1.51	43.0	16.2	4.9	11.3	30.1
B1	0-15	27.5	42.8	26.0	68.8	13.8	17.4	1.44	42.8	18.5	6.9	11.6	30.0
	15-30	28.5	44.2	21.8	66.0	14.2	19.8	1.48	41.9	18.4	6.5	11.9	31.7
B2	0-15	27.4	43.8	24.0	67.8	13.4	18.8	1.44	42.2	18.1	6.9	11.2	29.9
	15-30	29.7	44.6	21.8	66.4	13.3	20.3	1.47	40.9	17.9	6.2	11.7	30.9
Applied black soils over native red soils													
A2	0-15	11.3	20.4	12.6	33.0	18.3	48.7	1.50	34.0	30.0	15.9	14.1	47.5
	15-30	30.4	36.8	23.1	59.9	15.9	24.2	1.50	37.8	19.8	7.6	12.2	32.5
A3	0-15	12.9	22.0	14.2	36.2	19.3	44.5	1.46	35.8	30.3	14.8	15.5	48.7
	15-30	47.3	37.4	22.3	59.7	15.6	24.7	1.47	39.0	20.4	8.5	11.9	32.8
A4	0-15	12.4	22.2	11.6	33.8	17.9	48.3	1.47	33.9	29.9	16.3	13.6	48.5
	15-30	35.9	35.4	23.2	58.6	15.9	25.5	1.48	36.6	21.5	8.4	13.1	33.9
A5	0-15	14.5	19.6	11.2	30.8	18.7	50.5	1.48	36.5	29.2	15.3	13.9	48.3
	15-30	32.2	38.0	22.0	60.0	14.2	25.8	1.47	39.6	21.3	8.8	12.5	33.4
A6	0-15	13.7	22.4	11.2	33.6	18.6	47.8	1.46	34.6	30.6	16.9	13.7	47.6
	15-30	39.7	39.8	21.2	61.0	14.7	24.3	1.50	38.2	21.4	9.2	12.2	31.5
B3	0-15	12.8	21.8	12.2	34.0	19.8	46.2	1.46	33.9	29.4	15.6	13.8	47.7
	15-30	20.7	38.4	23.4	61.8	15.2	23.0	1.48	38.5	22.7	8.6	14.1	38.7
B4	0-15	11.5	24.2	11.4	35.6	17.8	46.6	1.46	35.2	30.4	16.8	13.6	47.2
	15-30	28.2	38.4	23.2	61.6	14.8	23.6	1.49	39.6	21.4	9.0	12.4	33.7
B5	0-15	12.1	21.0	10.0	31.0	18.1	50.9	1.46	31.9	30.9	16.2	14.7	49.1
	15-30	33.5	37.8	26.6	64.4	14.5	21.1	1.51	40.1	20.8	7.9	12.9	34.5
B6	0-15	12.7	21.2	11.2	32.4	19.2	48.4	1.45	33.1	30.4	15.6	14.8	50.4
	15-30	34.6	36.2	27.0	63.2	14.8	22.0	1.49	39.6	21.7	8.2	13.5	36.6
Native red soils													
Ovearal range	0-15	19.8-58.4	40.2-47.4	21.8-26.0	65.2-69.2	12.5-15.2	17.4-19.6	1.43-1.44	42.8-44.0	16.2-18.5	5.4-7.6	10.8-11.6	28.2-29.9
Ovearal mean	0-15	(33.3)	(43.5)	(24.2)	(67.7)	(13.8)	(18.5)	(1.45)	(42.7)	(17.6)	(6.7)	(10.9)	(29.2)
	15-30	21.3-58.5	43.6-44.6	21.8-22.4	66-66.5	12.6-14.2	19.8-21.4	1.47-151	40.9-44.8	16.2-19.34	6.2-7.8	11.3-11.9	30.1-31.7
	15-30	(34.5)	(44.2)	(22)	(66.2)	(13.3)	(20.5)	(1.50)	(42.7)	(18.0)	(6.4)	(11.6)	(31.0)
Applied black soils over native red soils													
Ovearal range	0-15	11.3-14.5	19.6-24.2	11.2-14.2	30.8-35.6	17.8-19.8	44.5-50.9	31.9-36.5	1.45-1.50	29.2-30.9	15.3-16.9	13.6-14.8	47.2-50.4
Ovearal mean	0-15	(12.7)	(21.6)	(11.7)	(33.4)	(18.6)	(48.0)	(34.3)	(1.46)	(30.12)	(15.9)	(14.2)	(48.3)
	15-30	20.7-47.3	35.4-39.8	21.2-27.0	58.6-64.4	14.2-15.9	21.1-25.8	37.8-40.1	1.47-1.51	19.8-22.7	7.6-9.2	11.9-14.1	31.5-38.7
	15-30	(33.6)	(37.6)	(23.6)	(61.1)	(15.1)	(23.8)	(38.7)	(1.48)	(21.2)	(8.5)	(12.7)	(34.2)

Table 3: Physico-chemical characteristics surface and sub surface soils of M.R.S, Vagarai

Field	Depth (cm)	pH (1:2.5)	EC (dSm^{-1})	OC ($g\ kg^{-1}$)	Exchangeable Cations (c mol (p+) kg^{-1})				Total Exchangeable Bases	Base saturation (%)	CEC (c mol (p+) kg^{-1})	$CaCO_3$ ($g\ kg^{-1}$)
					Ca	Mg	Na	K				
Native red soils												
A1	0-15	7.33	0.15	4.1	7.4	4.2	0.65	0.45	12.70	69.8	18.2	6.0
	15-30	7.58	0.16	3.9	6.5	3.3	0.51	0.39	10.70	56.9	18.8	9.0
A7 -A9	0-15	7.80	0.14	3.1	5.6	3.2	0.63	0.46	9.89	59.9	16.5	7.0
	15-30	7.76	0.13	2.9	6.9	2.9	0.48	0.34	10.62	70.3	15.1	9.0
B1	0-15	7.66	0.15	3.1	6.6	4.2	0.58	0.48	11.86	69.3	17.1	7.8
	15-30	7.48	0.21	3.3	7.4	3.3	0.36	0.36	11.42	64.2	17.8	6.6
B2	0-15	7.63	0.23	3.0	8.3	4.2	0.69	0.39	13.58	68.6	19.8	5.5
	15-30	7.55	0.15	2.6	7.4	3.1	0.66	0.33	11.49	53.7	21.4	6.0
Applied black soils over native red soils												
A2	0-15	8.00	0.44	5.4	20.4	7.6	0.80	0.54	29.34	70.9	41.4	27.0
	15-30	8.20	0.47	3.9	8.8	3.1	0.78	0.45	13.13	64.7	20.3	10.0
A3	0-15	8.10	0.45	5.0	21.4	7.8	0.66	0.49	30.35	72.1	42.1	21.0
	15-30	7.90	0.39	4.0	8.4	4.3	0.44	0.44	13.58	67.6	20.1	8.6
A4	0-15	7.83	0.39	4.7	19.6	8.2	0.86	0.52	29.18	72.2	40.4	42.0
	15-30	7.85	0.40	3.8	7.5	4.6	0.62	0.49	13.21	68.8	19.2	9.0
A5	0-15	8.00	0.32	5.1	20.6	7.6	0.92	0.58	29.70	73.2	40.6	37.0
	15-30	8.14	0.41	4.3	7.2	3.8	0.68	0.57	12.25	65.9	18.6	6.5
A6	0-15	8.25	0.47	4.7	19.2	8.6	0.90	0.70	29.40	70.1	41.9	38.0
	15-30	8.38	0.22	4.3	6.8	3.5	0.58	0.44	11.32	54.8	20.6	7.8
B3	0-15	7.49	0.29	5.4	21.2	6.8	0.86	0.52	29.38	68.6	42.8	33.0
	15-30	7.80	0.20	3.4	7.8	4.3	0.66	0.42	13.18	65.2	20.2	9.0
B4	0-15	8.34	0.37	5.4	19.8	7.8	0.81	0.61	29.02	68.1	42.6	32.0
	15-30	8.25	0.23	3.9	8.2	4.2	0.65	0.36	13.41	58.8	22.8	8.0
B5	0-15	7.78	0.36	5.5	20.2	7.5	0.85	0.58	29.13	70.7	41.2	39.0
	15-30	8.01	0.48	4.6	7.8	3.9	0.42	0.35	12.47	66.3	18.8	8.6
B6	0-15	8.35	0.47	5.6	22.1	8.8	0.96	0.66	32.52	78.9	41.2	35.0
	15-30	8.47	0.57	4.6	9.8	4.1	0.62	0.46	16.98	71.0	23.9	11.8
Native red soils												
Ovearal range	0-15	7.33-7.80	0.14-0.23	3.0-4.1	5.6-8.3	3.2-4.2	0.58-0.69	0.39-0.48	9.89-13.58	59.9-69.78	16.5-17.1	5.5-7.8
Ovearal mean	0-15	(7.60)	(0.17)	(3.3)	(6.9)	(3.9)	(0.63)	(0.44)	(12.0)	(66.9)	(17.9)	(6.6)
	15-30	7.48-7.55	0.15-0.21	2.6-3.9	6.5-7.4	2.9-3.3	0.36-0.66	0.33-0.39	10.62-11.49	53.69-70.3	15.1-21.4	6.0-9.0
	15-30	(7.59)	(0.16)	(3.2)	(7.1)	(3.15)	(0.50)	(0.35)	(11.05)	(61.3)	(18.3)	(7.7)
Applied black soils over native red soils												
Ovearal range	0-15	7.49-8.35	0.29-0.47	4.7-5.6	19.2-22.1	6.8-8.8	0.66-0.96	0.49-0.70	29.02-32.52	68.12-78.93	40.4-42.8	21.0-42.0
Ovearal mean	0-15	(8.01)	(0.39)	(5.2)	(20.5)	(7.85)	(0.84)	(0.57)	(29.78)	(71.6)	(41.6)	(33.8)
	15-30	7.80-8.47	0.20-0.57	3.4-4.6	6.8-9.8	3.1-4.6	0.42-0.78	0.35-0.57	11.32-14.98	54.8-71.04	18.6-23.9	6.5-11.8
	15-30	(8.1)	(0.37)	(4.1)	(8.03)	(3.97)	(0.60)	(0.44)	(13.05)	(64.8)	(20.5)	(8.8)

Physico-chemical characteristics

The pH of native soils ranges between 7.33 to7.80 and 7.48 to 7.55 in both surface and subsurface soils. Majority of these soils (85%) are moderately alkaline in soil reaction and appeared to be related to the nature of the parent material, climate, and topography. Increasing trends in pH are observed in subsurface soils caused by an increase in $CaCO_3$ in subsurface soils. The native soils were non saline and the EC values varied from 0.14 to0.23and 0.15 to0.21dS m^{-1},organic carbon content ranged from 3.0-4.1 g kg^{-1} and 2.6-3.9 g kg^{-1}in both the surface and subsurface respectively. Higher organic carbon content was recorded in surface soils as compared to subsurface soils could be attributed to the addition of farm yard manure and plant residues to surface horizons than in the lower horizons. The pH of application of applied black soils over native soils is moderately alkaline in soil reaction (7.49 to 8.35 and 7.80 to 8.47) and non saline varied from 0.29 to 0.47 and 0.20 to 0.57 dS m^{-1} in both the surface and subsurface soils respectively. The organic carbon content was low to medium (4.7-5.6 g kg^{-1}) in surface soils and low (3.4-4.6 g kg^{-1}) in subsurface soils. The amount of organic carbon decreases with depth and seems to be strongly related to the cropping history and prevailing environments.

Exchangeable bases in all the soils were in the order of $Ca^{++}>Mg^{++}>Na^{+}>K^{+}$ on the exchangeable complex. The exchangeable Ca, Mg, Na and K in native soils ranged from 5.6 to 8.3, 3.2 to 4.2, 0.58 to 0.69 and 0.39 to 0.48 c mol (p+) kg^{-1}5.6 to 8.3 in surface soils and 6.5to7.4, 2.9-3.3, 0.36-0.66, and 0.33to0.39 c mol (p+) kg^{-1}in subsurface soils respectively. The exchangeable Ca, Mg, Na and K in applied black soils ranged from 19.2 to 22.1, 6.8 to 8.8, 0.66 to 0.96, and 0.49 to 0.70 c mol (p+) kg^{-1} in surface soils and6.8 to 9.8, 3.1 to 4.6, 0.42 to 0.78, and 0.35 to 0.57 c mol (p+) kg^{-1}in subsurface soils respectively. The base saturation of the soils was moderate to high in native soils (59.9 to 69.78% and 53.69 to 70.3%) and high in applied black soils varied from 68.1 to 78.9 in surface soils and 54.8 to 71.0% in subsurface soils and are saturated with bases, especially Ca and Mg while calcium constitutes 60 to 65 percent and magnesium may constitute 20 to 25 percent of the exchange complex. The base saturation of applied subsurface soils was more than the native surface and subsurface soils.

The cation exchange capacity of native soils were medium and ranged from 16.5-17.1 and 15.1-21.4 c mol (p+) kg^{-1} in surface and subsurface soils. The cation exchange capacity of applied black soils were high in surface soils (40.4 to 42.8 c mol (p+) kg^{-1}) due to the dominance of smectite clay mineral in the fine clay fractions (Pal and Deshpande, 1987) and medium in subsurface soils ranged from 18.6 to 23.9 c mol (p+) kg^{-1} soil. The $CaCO_3$ content of native red soils (5.5 to 7.8 and 6.0 to 9.0 g kg^{-1}) and in applied black soils ranged from 21.0 to 42.0 and 6.5 to 11.8 g kg^{-1} in both the surface and sub surface soils.

Conclusion

The selected red soil of MRS, Vagarai were developed on weathered granite-gneiss parent material at gently sloping lands. The subsurface soils of applied black soils over native soils have high moisture retention capacity than native subsurface soils due to high deposition black soils as top layer which is having high clay content which leads the high storage of moisture content due to an increase in translocation of clay. The moisture retention at 33kpa (field capacity), 1500kPa (permanent wilting point) and available water capacity were more in application of applied black soils. The maximum water holding capacity in all was high in applied black soils over the native red soils. The application of black soils over native red soils is beneficial for retaining the more soil moisture for sustaining crop growth particularly in rainfed situations under changing climate.

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References

1. Blake GR, Hartze KH. Bulk density In Methods of Soil analysis part I (ed A Klute). American Society of Agronomy Incorporation Wrisconsin USA, 1986, 377-382
2. Chapman HO. Cation Exchange Capacity. In Methods of Soil Analysis Part-II (ed CA Black). American Society of Agronomy Incorporation Wisconsin, USA, 1965, 891-901.
3. Hirekurubar BM, Doddamani VS, Satyanarayana T. Some physical properties of Vertisols derived from different parent materials. J Indian Soc. Soil Sci. 1991; 39:242-245.
4. Jackson ML. Soil chemical analysis. India: Prentice Hall, 1973.
5. Murthy RS, Bhattacharjee JC, Landey RJ, Pofali RM. Distribution, characteristics and classification of Vertisols. Transactions of the 12th international Congress of Soil Science: Vertisols and Rice Soils of the Tropics. Symposia Papers II, New Delhi, India, 1982.
6. Piper CS. Soil and plant analysis. Hans Publishers, Bombay, 1966.
7. Sankaram, A. A Laboratory Manual for Agricultural Chemistry Published by Jaya Sing Asia Publishing House Bombay, 1966, 56.
8. Thangaswamy A, Naidu MVS, Ramavatharam M, Raghavareddy C. Characterization, Classification and Evaluation of Soil Resources in Sivagiri Micro-watershed of Chittoor District in Andhra Pradesh for Sustainable Land Use Planning Journal of the Indian Society of Soil Science. 2005; 53:11-21.
9. Vijaykumar R, Arokiyaraj A, Martin Devaprasath P. Nutrient strength and their relationship with soil properties of natural disaster proned coastal soils, J Chem. Pharm. Res. 2011; 3(3):87-92.
10. Walia CS, Rao YS. Characteristics and classification of some soils of Trans-Yamuna plains. J Indian Soc. Soil Sci. 1997; 45:156-162.
11. Walkly A, Black IA. An examination of the Dogiareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science 1934; 37:29-33