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Research Article

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Characterization of selected cotton growing soils of Wardha district, Maharashtra

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Summary

Nine cotton growing soils located on Deoli, Wardha, Karanja, Ashti tehsils of Wardha district, Maharashtra was characterized. Horizon-wise soil samples were collected and studied for morphological, physical and chemical properties. The soils were brown to very dark gray in colour, shallow (31 cm) to very deep (150 cm), silty clay loam to clay in texture, imperfectly to well drained and most of the soils had sub-angular blocky structure in the B horizon with a few of them having pressure faces and slickensides. The soil had mildly alkaline to strongly alkaline, all these soils were non-saline, organic carbon was low and decreased with depth, high CEC with calcium as dominant cation on exchange complex. These soils were classified as Typic Haplusterts, Typic Calciusterts, Typic Haplustepts, Typic Calciustepts and Lithic Ustorthents at subgroup level.

Key words : Cotton growing soils, Soil characterization, Classification

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Introduction

The population of the country is expected to grow to 1.6 billion by the year 2050 from the current level of 1.1 billion implying a greater demand for food. The cereal requirement of India by 2020 will be between 257 and 296 million tons depending on income growth (Kumar, 1998). The same will have to be produced from the same or even shrinking land resources. Thus, by 2020, the average yield of cereal needs to be increased by about 60 per cent. The scenario for many other crops is no better too. Cotton (*Gossypium* spp.) is an important cash crop and leading fibre crop which is mainly cultivated for its fibre and contributing to about 85 per cent of raw material to textile industry comprising more than 1000 textile mills. It is also an important commodity for export in the form of raw cotton, cotton yarn and other value added textile goods.

India, although has the largest area under cotton, its average annual cotton production is, however, just 15.8 million bales, a very low figure for the vast area the crop occupies. The major hurdle is its low productivity (306 kg/ha) which is not at all encouraging when compared to the developed economies (China 700 kg/ ha, USA 698 kg/ha) or even the neighbouring Pakistan (488 kg/ha) (Ramasundaram and Gaibhiye, 2003). Cotton is grown in rainy season in semi-arid regions. The crop is grown in Maharashtra, Andhra Pradesh and Gujarat followed by Punjab, Haryana, Karnataka and Madhya Pradesh. In north India states of Punjab, Haryana and Rajasthan, the crop is irrigated whereas in other states, it is partially irrigated or rain-fed.

Maharashtra is world renowned for cotton production and is popularly known as the black cotton soil of deccan plateau a traditional producer of cotton. Almost the crop is rain-fed which accounts for 34 per cent of the cotton area and 27 per cent national production. A yield gap of 840 kg/ha of cotton was reported in Maharashtra by Aggarwal *et al*. (2008). The physical constraints that limit cotton yield include, amongst others, dependence on monsoon, unsuitable soils, non-certificated seed, non-recommended seed rate, delayed sowing, multiplicity of genotypes, non-recommended genotypes, non-descript cultivars, improper spacing, subdued input use, endemic to pests and competition from other crops. A brighter side of the picture is that the controllable constraints exceed the uncontrollable ones. In Vidarbha region, cotton is grown on an area of 13.00 lakh ha with production of 27 lakh bales of cotton (2008-09). The productivity of cotton is low (350 kg/ha) in Vidarbha as compared to national (502 kg/ha). The main reason for the low productivity of cotton in Vidarbha is its dependence on the monsoon rain and about 95 to 98 per cent area is under rain-fed cultivation.

Resource and Research Methods

Collection of soil samples :

The study area is located in Wardha district of Maharashtra between 20°18’ to 21°21’ N latitude and 78°30’ to 79°15’E longitude. The geological formation of the area mainly consists of Lower Eocene to Upper Cretaceous Deccan flood basalt which is commonly known as traps. The rocks are mainly basaltic in composition and show the typical spheroidal weathering. The climate of the area is tropical dry sub-humid and annual precipitation in the area is about 1134 mm of which about 87 per cent is received through south west monsoon (June to September). The mean maximum and minimum temperature is 32.6°C and 19.4°C. The annual potential evapo-transpiration is about 1460 mm. The relative humidity, in general, varies from 21.3 to 90.0 per cent, respectively. Nine soil profiles representing different identified soil series of Wardha district were studied in village Kutki, Karanjibhogay, Sirpur, Deoli, Talegaon-1, Satoda, Sewagram, Karanja and Talegaon-2 and horizon-wise 36 soil samples were collected and studied for morphological, physical and chemical properties following standard procedures (Jackson, 1967 and Black, 1965). Particle size analysis of the sample was carried out by using International pipette method. Bulk density (dry clod) was determined by clod coating method. The moisture retention at 33 kPa and 1500 kPa was determined using Pressure Plate apparatus. Soil pH and EC were determined in soil water suspention 1:2.5 (Jackson, 1967 and Richards, 1954), respectively. Soil organic carbon was determined by Walkley and Black method (Jackson, 1973). Calcium carbonate was determined by rapid titration method (Piper, 1950). The soils were classified as per guidelines given in Key to Soil Taxonomy (Soil Survey Staff, 1992).

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Soil morphology :

The relevant morphological features of the pedons are presented in Table 1. These shallow to deep soils had texture varying from silty clay loam to clay. The wide textural variation might be due to different processes of soil formation, *in-situ* weathering and translocation of clay. Pedons had their Munsell colour notation in the hue of 10 YR with value 3 to 4 and chroma 1 to 3. Pedons 1,2,3,4,6,7 and 9 had very dark grayish brown colour in surface and dark brown to very dark gray colour in sub-surface. In pedon 5 and 8, the surface horizons exhibited dark grey brown and brown colour but the sub-surface colour was very dark gray to brown. The structure of soils was sub-angular blocky type with pressure faces and slickensides.

Physical characteristics :

The clay content in soils ranged from 34.81 to 67.59 per cent and increased with depth (Table 2). This might be due to the illuvation or translocation of clay from the surface to sub-surface horizon. The silt content ranged from 18.00 to 53.74 per cent and had an irregular trend of distribution with depth. The content of the sand varied from 0.80 to 42.60 per cent, show any particular trend. High amount of clay in majority of the soils indicate that these are developed from basaltic parent material. Bulk density increased with depth and clay content in all the pedons. Surface horizon showed lower bulk density as compared to subsurface horizons. It may be due to relatively low organic carbon content and disturbance due to cultivation practices. High value of subsurface layers may be due to high smectitic clay and over-burden

Table 1: Morphological properties of soils

Horizon	Depth (cm)	Boundary D	Boundary T	Colour	Texture	Structure	Consistence D	Consistence M	Consistence W	Pores S	Pores Q	Roots S	Roots Q	Effervescence	Special features
Pedon-1 Very fine, smectitic (calcareous), hyperthermic, Typic Haplusterts															
Ap	0-17	c	s	10YR3/2	c	m_2 sbk	sh	fi	s/p	f	c	vf	f	es	Cracks 3-5 cm wide in Ap and Bw horizons shiny pressure faces with intersecting slickensides (in Bss1 to Bss3 horizon)
Bw	17-53	c	s	10YR3/2	c	m_1 sbk	vh	fi	s/p	f	m	vf	f	es	
Bss1	53-83	g	w	10YR3/2	c	m_1 sbk	vh	fi	s/p	f	vf	vf	f	es	
Bss2	83-101	c	s	10YR3/2	c	m_1 sbk	vh	fi	s/p	f	vf	vf	f	es	
Bss3	101-150	g	w	10YR5/3	c	m_1 sbk	h	fi	s/p	-	-	vf	f	es	
Pedon-2 Very fine, smectitic (calcareous), hyperthermic, Typic Haplustepts															
Ap	0-18	c	s	10YR3/2	c	m_1 sbk	h	fi	s/p	vf	m	f	m	es	
Bw1	18-56	c	s	10YR3/2	c	m_1 sbk	sh	fi	s/p	f	m	f	m	es	
Bw2	56-85	c	s	10YR3/2	c	m_3 sbk	h	fi	s/p	f	m	f	m	es	
Bw3	85-150	c	s	10YR3/2	c	m_3 sbk	h	fi	s/p	f	vf	f	m	es	
Pedon-3 Fine, smectitic (calcareous), hyperthermic, Typic Haplustepts															
Ap	0-21	c	s	10YR3/2	c	m_1 sbk	sh	fi	s/p	f	c	c	f	es	
Bw1	21-60	c	s	10YR3/2	sicl	m_2 sbk	h	fi	s/vp	f	f	m	f	es	
Bw2	60-105	c	s	10YR3/2	sicl	m_2 sbk	h	fi	s/p	f	vf	f	f	es	
Bw3	105-121	g	w	10YR3/3	sic	m_2 sbk	h	fi	s/p	f	vf	vf	f	es	
Ck	121-150	g	w	10YR3/3	sic	m_1 sbk	h	fi	s/p	f	vf	vf	f	es	
Pedon-4 Fine, smectitic, hyperthermic, Typic Calciustepts															
Ap	0-19	c	s	10YR3/2	sic	m_2 sbk	sh	fi	s/p	f	m	vf	f	es	
Bw1	19-53	c	s	10YR3/2	sic	m_1 sbk	vh	fi	s/p	f	m	vf	f	es	
Bw2	53-97	c	s	10YR3/1	sic	m_2 sbk	vh	fi	s/p	f	vf	vf	f	es	
Bw3	97-127	g	w	10YR3/1	sic	m_2 sbk	vh	fi	s/p	f	vf	vf	m	es	
Ck	127-150	g	w	10YR3/1	sic	m_2 sbk	h	fi	s/p	-	-	-	m	es	
Pedon-5 Fine, smectitic, hyperthermic, Typic Calciustepts															
Ap	0-18	c	s	10YR4/2	c	m_2 sbk	sh	fr	s/p	f	m	vf	f	es	
Bw	18-52	c	s	10YR3/1	sic	m_2 sbk	vh	fi	s/vp	f	m	vf	f	es	
Bwk1	52-97	c	s	10YR3/1	sic	m_2 sbk	vh	fi	s/vp	f	vf	vf	f	es	
Bwk2	97-116	g	w	10YR3/1	sic	m_2 sbk	vh	fi	s/vp	f	vf	vf	f	es	
Bck	116-150	g	w	10YR4/3	sic	m_3 sbk	h	fi	s/vp	f	vf	vf	f	es	
Pedon-6 Fine, smectitic (calcareous), hyperthermic, Typic Calciusterts															
Ap	0-19	c	s	10YR3/2	sic	m_1 sbk	sh	fr	s/p	vf	c	vf	m	es	Cracks 35 cm extends upto 75 cm shiny pressure faces with intersecting slickensides (in Bss to Bssk horizon)
Bw1	19-56	c	s	10YR3/2	sic	m_1 sbk	h	fi	s/p	f	vf	vf	m	es	
Bss	56-86	c	s	10YR3/2	sic	m_1 sbk	h	fi	s/p	f	vf	vf	m	es	
Bssk	86-116	c	s	10YR3/3	sic	m_1 sbk	h	fr	s/sp	f	vf	vf	m	es	
Bc	116-150	g	w	10YR3/3	cl	m_3 sbk	h	fr	s/sp	f	-	vf	m	es	
Pedon-7 Fine, smectitic (calcareous), hyperthermic, Lithic Haplustepts															
Ap	0-19	c	s	10YR3/2	c	m_2 sbk	sh	fi	s/p	vf	m	vf	m	-	
Bw1	19-41	c	s	10YR3/2	c	m_2 sbk	h	fi	s/vp	f	m	vf	m	-	
Bw2	41-78	g	w	10YR3/2	c	m_2 sbk	h	fi	s/p	f	m	vf	m	-	
Pedon-8 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents															
Ap	0-14	c	s	10YR4/3	cl	m_2 sbk	sh	fi	s/p	f	m	vf	m	-	
Cr	14-24			------------------------------------weathered basalt------------------------------------											
Pedon-9 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents															
Ap	0-13	c	s	10YR3/2	c	m_2 sbk	h	fi	s/p	f	vf	f	m	-	
B	13-31	c	s	10YR3/2	c	m_2 sbk	sh	vfi	v/p	f	vf	f	m	-	
	31+			------------------------------------weathered basalt------------------------------------											

Table 2: Physical properties of the soils

Horizon	Depth (cm)	Particle size distribution (%)			Textural class	Bulk density (Mg/m^3)	Water retention (%)		AWC (mm/horizon)	AWC (mm/M)
		Sand (%)	Silt (%)	Clay (%)			33 kPa	1500 kPa		
Pedon -1 Very fine, smectitic (calcareous), hyperthermic, Typic Haplusterts										
Ap	0-17	2.18	33.66	64.15	c	1.73	44.63	29.77	43.7	259
Bw	17-53	1.79	33.51	64.69	c	1.76	43.00	29.67	84.4	
Bss_1	53-83	1.77	33.21	65.00	c	1.80	46.67	29.47	92.8	
Bss_2	83-101	2.59	34.99	62.40	c	1.62	49.10	32.48	48.4	
Bss_3	101-150	8.14	40.98	50.86	c	1.57	45.71	30.21	119.2	
Pedon-2 Very fine, smectitic (calcareous), hyperthermic, Typic Haplustepts										
Ap	0-18	1.73	33.40	64.86	c	1.65	35.09	24.07	32.7	226
Bw_1	18-56	1.00	36.68	62.30	c	1.82	38.57	25.50	90.3	
Bw_2	56-85	0.80	34.17	64.33	c	1.73	40.35	26.97	67.1	
Bw_3	85-150	0.91	31.53	67.59	c	1.77	43.27	30.29	149.3	
Pedon-3 Fine, smectitic (calcareous), hyperthermic, Typic Haplustepts										
Ap	0-21	7.49	39.06	53.43	c	1.68	36.96	23.37	47.9	228
Bw_1	21-60	5.15	35.49	59.35	sici	1.83	38.40	26.47	85.1	
Bw_2	60-105	6.23	31.16	62.06	sici	1.88	40.63	26.60	118.6	
Bw_3	105-121	2.02	40.55	57.42	sic	1.76	41.80	27.28	40.8	
Ck	121-150	1.15	49.03	49.03	sic	1.70	37.21	26.94	50.6	
Pedon-4 Fine, smectitic, hyperthermic, Typic Calciustepts										
Ap	0-19	2.53	47.33	50.13	sic	1.73	38.10	27.26	35.6	227
Bw_1	19-53	2.09	42.78	55.12	sic	1.76	39.28	27.80	68.6	
Bw_2	53-97	1.45	45.27	54.72	sic	1.92	42.20	28.34	117.0	
Bw_3	97-127	9.31	46.26	44.41	sic	1.98	31.06	17.95	77.8	
Ck	127-150	7.40	46.07	46.51	sic	1.73	27.84	17.14	42.5	
Pedon-5 Fine, smectitic, hyperthermic, Typic Calciustepts										
Ap	0-18	23.48	41.69	34.81	c	1.49	35.29	23.19	32.4	216
Bw	18-52	3.90	49.62	46.47	sic	1.74	39.36	25.91	79.5	
Bwk_1	52-97	3.88	47.95	48.16	sic	1.85	37.81	25.42	103.1	
Bwk_2	97-116	2.58	47.76	49.65	sic	1.76	39.41	27.34	40.3	
Bck	116-150	4.32	53.74	41.92	sic	1.67	36.86	24.61	69.5	
Pedon-6 Fine, smectitic (calcareous), hyperthermic, Typic Calciusterts										
Ap	0-19	8.81	47.65	43.53	sic	1.76	37.08	24.44	42.2	207
Bw_1	19-56	11.37	44.00	44.62	sic	1.73	36.13	25.82	65.9	
Bss	56-86	4.27	42.06	53.65	sic	1.84	39.19	27.19	66.2	
Bssk	86-116	3.44	40.17	56.38	sic	1.83	38.61	26.57	66.0	
Bc	116-150	24.75	30.87	44.36	ci	1.78	34.53	22.71	71.5	
Pedon-7 Fine, smectitic (calcareous), hyperthermic, Lithic Haplustepts										
Ap	0-19	23.5	27.3	49.2	c	1.58	37.00	24.00	39.0	194
Bw_1	19-41	21.5	20.5	58.0	c	1.62	35.90	25.18	38.2	
Bw_2	41-78	20.4	18.0	61.6	c	1.66	40.22	28.11	74.3	
Cr	78 cm				……. Weathered basalt………					
Pedon-8 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents										
Ap	0-14	42.6	21.0	36.4	ci	1.97	20.2	10.9	25.6	106
Cr	14-24			-------------------------------Weathered basalt-----------------------------						
Pedon-9 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents										
Ap	0-13	16.5	30.9	52.6	c	1.90	30.4	19.6	26.6	202
B	13-31	16.2	30.0	54.8	c	1.86	32.0	21.2	36.1	
Cr	31+			-------------------------------Weathered basalt-----------------------------						

Table 3: Chemical properties of soils

Horizon	Depth (cm)	pH (1:2.5)	EC (1:2.5) (dSm^{-1})	Org.C. (%)	$CaCO_3$ (%)	Exchangeable bases Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Sum of bases	CEC	B.S. (%)
						---cmol(P^+) kg^{-1}---						
Pedon-1 Very fine, smectitic (calcareous), hyperthermic, Typic Haplusterts												
Ap	0-17	7.9	0.15	0.85	2.14	43.6	14.8	0.29	0.90	59.59	68.95	86.42
Bw	17-53	7.6	0.35	0.61	2.77	48.0	10.4	0.36	0.61	59.37	63.71	93.18
Bss_1	53-83	7.9	0.19	0.50	3.57	48.4	12	0.38	0.49	61.27	69.02	88.76
Bss_2	83-101	8.2	0.15	0.24	7.06	47.6	26	0.37	0.48	74.45	66.60	96.77
Bss_3	101-150	8.2	0.14	0.16	10.56	43.6	13.2	0.34	0.39	57.13	58.62	97.45
Pedon-2 Very fine, smectitic (calcareous), hyperthermic, Typic Haplustepts												
Ap	0-18	8.0	0.28	0.75	4.71	41.6	12.8	0.40	0.85	55.65	57.17	97.34
Bw_1	18-56	8.1	0.19	0.55	6.29	41.4	19.2	0.46	0.58	52.64	55.30	95.18
Bw_2	56-85	8.2	0.14	0.39	6.36	41.2	13.6	0.60	0.50	55.89	61.63	90.70
Bw_3	85-150	8.1	0.23	0.3	6.05	40.0	16.4	0.56	0.48	57.44	58.44	98.28
Pedon-3 Fine, smectitic (calcareous), hyperthermic, Typic Haplustepts												
Ap	0-21	8.2	0.15	0.73	10.21	43.2	11.2	0.31	1.31	56.02	60.69	92.30
Bw_1	21-60	8.1	0.19	0.39	10.71	44.0	13.2	0.40	0.88	58.48	61.96	94.39
Bw_2	60-105	8.3	0.14	0.26	10.80	42.4	10.4	0.52	1.19	54.51	53.00	102.8
Bw_3	105-121	8.3	0.16	0.17	11.93	33.2	16	0.52	1.01	50.73	54.81	92.55
Ck	121-150	8.4	0.15	0.12	15.39	29.2	14.4	0.63	1.16	45.39	47.77	95.01
Pedon-4 Fine, smectitic, hyperthermic, Typic Calciustepts												
Ap	0-19	8.2	0.25	1.08	9.89	31.6	29.6	0.69	1.19	58.08	61.87	93.87
Bw_1	19-53	8.2	0.25	0.63	8.85	41.2	18	0.89	0.96	61.05	62.56	97.58
Bw_2	53-97	8.5	0.27	0.57	9.92	39.6	21.2	0.92	0.95	62.67	63.40	98.84
Bw_3	97-127	8.2	0.34	0.28	23.12	28.8	18.8	0.70	0.65	40.95	45.05	90.89
Ck	127-150	8.3	0.23	0.3	23.36	26.8	18.4	0.67	0.74	38.61	45.04	85.72
Pedon-5 Fine, smectitic, hyperthermic, Typic Calciustepts												
Ap	0-18	8.9	0.35	0.60	9.58	33.6	14.8	1.09	3.70	54.45	67.05	81.20
Bw	18-52	8.1	0.43	0.55	11.00	40.4	12.4	1.23	0.45	54.48	54.81	99.39
Bwk_1	52-97	8.1	0.24	0.44	15.05	35.2	16.2	1.26	0.53	53.19	59.89	88.81
Bwk_2	97-116	8.3	0.37	0.24	20.14	27.2	14.2	2.58	0.60	44.58	51.75	86.14
Bck	116-150	8.4	0.32	0.14	23.63	27.2	13.2	1.17	0.60	42.17	45.63	92.41
Pedon-6 Fine, smectitic (calcareous), hyperthermic, Typic Calciusterts												
Ap	0-19	8.1	0.21	1.25	6.19	.35.6	13.2	1.35	1.54	67.5498	55.87	92.51
Bw_1	19-56	8.2	0.18	0.75	5.59	32.8	16.4	1.30	1.84	66.7982	55.29	94.66
Bss	56-86	8.2	0.12	0.63	9.66	38.4	15.4	0.78	0.53	68.2096	57.03	96.63
Bssk	86-116	8.7	0.22	0.46	18.00	30.4	26	1.34	0.42	58.5126	58.70	99.08
Bc	116-150	8.4	0.50	0.16	14.17	32.8	16.4	1.29	0.33	52.135	52.23	97.12
Pedon-7 Fine, smectitic (calcareous), hyperthermic, Lithic Haplustepts												
Ap	0-19	7.9	0.16	0.86	1.20	31.4	18.8	0.9	0.40	51.3	52.0	96.8
Bw_1	19-41	8.1	0.14	0.39	2.62	30.6	19.5	0.8	0.40	51.3	53.3	98.2
Bw_2	41-78	8.1	0.06	0.35	4.22	36.0	20.0	0.9	0.30	57.2	57.6	98.4
Pedon-8 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents												
Ap	0-14	7.6	0.13	0.46	-	23.20	8.61	0.19	0.26	32.26	34.2	96.0
Pedon-9 Fine, smectitic (calcareous), hyperthermic, Lithic Ustorthents												
Ap	0-13	7.8	0.11	0.54	-	32.20	10.60	0.30	0.81	43.91	48.2	94.2
B	13-31	7.8	0.09	0.39	-	38.20	11.20	0.40	0.64	50.44	50.9	96.9

leading to compaction and formation of slickenside, leading to strong structural aggregate formation and high bulk density (Gupta and Gupta, 1978). The moisture retention characteristics of the soils were studied to determine the available water capacity of the soils varies from 25.6 to 149.3 mm/horizon at 33 kPa and 1500 kPa.

Chemical characteristics :

The pH of the soil was mildly alkaline to strongly alkaline. The pH of surface soils ranged from 7.6 to 8.9 and soil pH increased with depth thereby indicating accumulation of bases from soil surface to subsurface. The electrical conductivity values in the soils are very low and ranged from 0.06 to 0.50 dSm^{-1} low EC values indicate that these soils are non-saline. The organic carbon contents of the soils showed wide variations and ranged from 0.12 to 1.25 per cent. A regular decrease in organic carbon which was observed in all pedons. Calcium carbonate content of the soils increases with depth and it ranges from 1.20 to 23.63 per cent. The increasing trend of lime with depth may be due to its leaching from upper horizons and, thereafter, its precipitation at lower horizons as also substantiated by its highest content at the lowest horizon. Similar trend was also observed by Kadao (1997) in some soils of Wardha district. Exchangeable cations indicate that all the soils are dominated by Ca^{++}, followed by Mg^{++}, K^{+} and Na^{+}. This may be due to basaltic parent material where plagioclase feldspar and ferromagnesian minerals are dominant (Krishnan, 1982). The soils have calcium, potassium, magnesium, sodium content ranging from 23.20 to 48.41, 0.26 to 3.70, 8.61 to 29.6, 0.19 to 2.58 cmol (p^{+}) kg^{-1}. Most of the pedons have relatively high Ca^{++} contents. A high Ca^{++} in exchange complex is advantageous for formation of stable aggregates which is essential for aeration in clayey soils (Pustole, 1988). The CEC of the soils ranged from 34.2 to 69.02 cmol (P^{+}) kg^{-1} (Table 3). Variations in CEC of the soils could be due to the corresponding variation in clay content. High values of CEC of the soils could be attributed to high clay content and smectitic nature of the clay minerals (Pal and Deshpande, 1987). Soil is saturated with bases (Ca, Mg, Na and K) is frequently used as an indicator of soil fertility and in soil classification (FAO-UNESCO, 1973). All the soils are highly base saturated, the base saturation per cent ranging from 81.2 to 102.8 it is a good indicator of soil fertility.

Conclusion :

It may be concluded that in study area major limitation for cotton production is shallow depth, poor organic carbon content, non-availability of sufficient soil moisture, imperfectly drained soils, inadequate input use (fertilizers and manures). Good cotton production could be achieved through providing suitable genotypes and technology for the shallow depth soils, application of recommended dose of FYM and other plant nutrients and community bore wells for irrigation. Based on the soil and site characteristics it is possible to adopt proper soil conservation measures and management practices for cotton production in long term.

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