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Characterization and classification of some typical banana growing soils of Wardha district of Maharashtra

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Abstract : Eight typical pedons supporting banana in Wardha district of Maharashtra were characterized and assessed for their suitability. The soils are developed in basaltic alluvium and are deep, calcareous and brown to very dark greyish brown in colour (10YR). The texture of pedons ranged from loamy sand to clay (10.7 to 65.4 per cent clay) in different horizons. The soils are alkaline and pH ranged from 7.9 to 8.4. In general surface horizons had higher organic carbon than the underlying horizons but reverse trend for $CaCO_3$ distribution was noticed. The water retentions at 33kPa and 1500 kPa and CEC are highly dependent on clay content. The occurrence of coarser texture (below 50 cm) was advantageous for banana in view of drainage. Based on soil suitability criteria, local experience and yield, pedon 8 is rated as highly suitable, pedons 1 and 6 as marginally suitable and others as moderately suitable.

Additional keywords: Soil parameters, banana productivity, suitability.

Introduction

Banana (*Musa paradisiacal L.*) is one of the most important fruit crops grown in India and contributes approximately 31.74 per cent in fruit pool of the country. In Maharashtra, banana cultivation is mostly confined in irrigated semi-arid tracts of Jalgaon, Parbhani, Nanded and Wardha (sub-humid) which share about 26 per cent of total production of India. Concentrated research has been carried out on water and nutrient management for banana (Dagde 1986; Das and Mohan 1993; Palaniappan and Yerriswamy 1996; Jeyabaskaran *et al.* 2001) but no serious attempt has been made to give impetus on soil-site characteristics, suitability and classification except one by Sidhu *et.al.* (1989) in Jalgaon district. Therefore the present study has been done to characterize and classify some typical

Table 1. Site characteristics*

Characteristics	Pawnar (P1)	Mohi (P2)	Hingni (P3)	Hingni (P4)	Hingni (P5)	Vadgaon (P6)	Vadgaon (P7)	Pawnar (P8)
Latitude and	20°46'52"N	20°53'34"N	20°54'21"N	20°54'48"N	20°54'24"N	20°52'39"N	20°51'35"N	20°47'23"N
Longitude	78°40'09"E	78°43'05"E	78°42'58"E	78°42'51"E	78°43'00"E	78°40'39"E	78°40'48"E	78°40'23"E
Elevation (m above msl)	250	280	280	280	280	270	265	250
Drainage	Moderately well drained	Well drained	Well drained	Well drained	Well drained	Moderately well drained	Moderately well drained	Well drained
Yield (t/ha)	45	75	80	92	68	50	80	110

*The physiography, parent material, slope and erosion for all the pedons are alluvial plain, basaltic alluvium, 1 to 3 per cent and slight erosion, respectively.

banana growing soils of the Wardha district of Maharashtra for their suitability assessment.

Materials and methods

The study area is located in Selu and Wardha tehsils of the Wardha district. (Table 1). After thorough traversing and considering the yield differences, eight pedons have been exposed and studied morphometrically (Soil Survey Division Staff 1995). The horizon-wise soil samples were collected and analysed following standard procedures (Jackson 1973). The suitability of banana growing soils have been worked out relating soil-site characteristics of pedons and suitability criteria (Sys *et al.* 1993) and banana productivity.

The area falls in tropical dry subhumid monsoonic type climate with annual rainfall of 934 mm and PET of 1430 mm. The mean annual temperature is 26°C with mean maximum and minimum temperatures of 32.6°C and 19.4°C, respectively. In general, the relative humidity varies from 33 to 80 per cent but increases in rainy season. However, humidity in banana orchard is modified by regular irrigation and putting papaya/castor plants/hedge on bunds. The soil moisture and temperature regimes are *Ustic* and *Hyperthermic,* respectively.

Results and discussion

Morphological characteristics

The colour (dry/moist) of the pedons is in hue 10YR, with value varying from 3 to 5 and chroma 2 to 3. The P1, P6 and P7 are darker than the other pedons owing to higher clay content and restricted drainage. P2, P3, P4, P5 and P8 are located near to drainage channels associated with diffused lime throughout the profile which might have acted as modifier in matrix colour. Pedons (P1 and P6) showed typical angular blocky structure particularly in the sub-soils and others have dominantly subangular blocky structure (Table 2).

The pedons are deep (>100 cm) and developed on recent alluvium. The coarse fragments mainly consisted of calcretes

which increase with depth. More than 5 mm wide cracks, pressure faces (P1, P2, P6, P7) and slickensides close enough to intersect are associated with P1 and P6 exhibiting the distinct morphology among them. Although all the pedons are developed in basaltic alluvium, the texture varied from clay to loamy sand in different horizons owing to physiographic position and influence of paleochannels.

Physical characteristics

The data presented in table 2 indicate that pedons 3 (BC horizon) and 5 (Ap to BC horizons) have coarse fragment (> 2mm) more than 15 per cent. The Pedons 1 and 6 (Vertisols) have clay more than 67 per cent throughout the profile with a tendency to increase with depth. However, in other pedons, clay content ranges from 10.7 to 65.4 per cent in different horizons with no definite trend of decrease or increase with depth except for pedons P4 and P5. The bulk density ranges from 1.49 to 1.86 Mg m^{-3} in different horizons of pedons which is dependent on mechanical composition and compression of the horizons. The water retentions varied from 13.5 to 52.9 per cent at 33 kPa and 6.2 to 33.9 per cent at 1500 kPa in different horizons and these values are more dependent on clay content (Srivastava *et al.* 1991).

Chemical characteristics

The pH of the soils range from 7.9 to 8.4 (moderately to strongly alkaline) owing to the presence of base rich clay particles. The $CaCO_3$ content is as low as 20 mg kg^{-1} in pedon 1 and 198 mg kg^{-1} in pedon 3 and, in general, increased with depth. Surface horizons have more of organic carbon (5.5 to 8.7 mg kg^{-1}) and that decreased in sub-surface and sub-soils to a minimum of 1.4 mg kg^{-1} in P7. CEC is very high in pedons 1 and 6 [>64 cmol(p+)kg^{-1}] but in other pedons it is not more than 50 cmol(p+)kg^{-1} except surface and sub-surface horizons of pedon 2 and Bw3 horizon of pedon 7 with lowest CEC of 8.7 cmol(p+)kg^{-1} in 2C horizon of P8 and, in general, CEC data followed the trend of clay distribution in profiles.

Classification

Based on morphometric, physical and chemical characteristics, the pedons were grouped in different taxa. Pedon 1 and Pedon 6 which are deep (>50 cm) with cracks, have clay more than 30 per cent and also slickensides (>25 cm thick zone) qualify for order Vertisols and meet the requirement for the subgroup Typic Haplusterts with very- fine textural family class. The P2, P3, P4, P5, P7 and P8 possess ochric epipedon underlain by cambic sub-surface diagnostic horizon and, hence, these have been grouped under order Inceptisols. In view of *Ustic* moisture regime for the region, the pedons qualify for Ustepts (suborder). These do not have duripan/calcic horizon and hence classified under Haplustepts great group and meet the central concept of Typic subgroup. The pedon P4 and P8 at a depth of 125 cm (assumed) below the mineral soil surface, had organic carbon of 0.2 per cent or more and no densic, lithic or paralithic contact

Table 2. Some relevant morphological, Physical and chemical characteristics of soils

Depth (m)	Hori-zon	Colour (moist)	Structure	Coarse fragment (%) (v/v)	Sand (0.05-2.0mm)	Clay <0.002 mm)	Water Retention		Bulk Density (Mg m^{-1})	pH (1:2.5)	CEC [cmol (p+)kg^{-1}]	Org.C. (g kg^{-1})	$CaCO_3$ (g kg^{-1})
							33 kPa (%)	1500 kPa (%)					
Pedon – 1 : Very-fine, smectitic, hyperthermic Typic Haplusterts													
0.00-0.09	Ap	10YR 3/2	m 2 sbk	0.7	08.7	68.9	49.3	32.1	1.75	8.0	65.93	8.4	25
0.09-0.22	AB	10YR 3/2	m 2 sbk	0.7	07.3	70.4	48.9	31.5	1.79	8.0	66.10	6.7	26
0.22-0.44	Bw	10YR 3/2	m 2 sbk	0.4	06.9	72.3	50.1	31.2	1.81	8.1	70.56	5.6	20
0.44-0.67	Bss1	10YR 3/2	c 3 abk	0.4	05.3	73.1	51.3	32.3	1.85	8.0	70.87	5.3	28
0.67-0.92	Bss2	10YR 3/2	c 3 abk	1.1	03.5	74.2	52.7	33.9	1.87	8.1	72.52	4.8	30
0.92-1.26	Bss3	10YR 3/2	c 3 abk	1.4	04.1	75.4	52.9	33.5	1.88	8.0	72.20	4.0	32
Pedon – 2 : Fine, smectitic, hyperthermic Typic Haplustepts													
0.00-0.14	AP	10YR 3/2	m 2 sbk	2.8	08.2	68.9	40.3	25.3	1.73	7.9	62.03	6.5	102
0.14-0.37	Bw	10YR 3/2	m 2 sbk	1.4	13.6	70.4	38.7	25.3	1.77	8.2	56.85	6.0	105
0.37-0.63	BC1	10YR 4/2	m 2 sbk	10.0	24.4	72.3	35.4	21.7	1.75	8.2	38.37	3.5	127
0.63-0.87	BC2	10YR 4/2	m 2 sbk	9.2	23.8	73.1	30.4	19.5	1.75	8.3	36.82	2.0	138
0.87-1.26+	BC3	10YR 4/2	m 2 sbk	10.0	24.2	74.2	31.8	21.9	1.74	8.3	36.74	1.8	187
Pedon - 3 : Coarse-loamy, mixed, hyperthermic Typic Haplustepts													
0.00-0.14	Ap	10YR 5/3	m 2 sbk	3.5	37.1	29.4	33.1	18.5	1.61	8.2	28.28	6.7	104
0.14-0.32	Bw1	10YR 4/3	m 2 sbk	12.1	53.6	19.4	22.2	14.0	1.64	8.3	18.10	5.0	114
0.32-0.50	Bw2	10YR 4/3	m 2 sbk	17.7	54.3	13.8	20.9	11.7	1.65	8.4	13.20	4.7	117
0.50-0.73	Bw3	10YR 4/3	m 2 sbk	14.4	52.8	12.6	22.7	12.9	1.57	8.4	11.71	3.5	136
0.73-1.01	Bw4	10YR 4/3	m 2 sbk	7.2	65.6	10.6	15.8	7.6	1.58	8.3	10.24	3.0	158
1.01-1.32	BC	10YR 4/3	m 2 sbk	44.4	57.3	10.7	18.7	10.7	1.60	8.3	09.81	2.2	198
Pedon - 4 : Coarse-loamy, mixed, hyperthermic Fluventic Haplustepts													
0.00-0.15	Ap	10YR 3/3	m 2 sbk	10.0	32.8	42.2	38.3	21.4	1.62	8.2	40.18	8.0	101
0.15-0.33	Bw	10YR 4/3	m 2 sbk	5.7	37.6	37.6	30.1	18.4	1.69	8.2	35.50	7.2	132
0.33-0.59	BC	10YR 4/3	m 1 sbk	2.8	50.2	20.6	32.1	14.0	1.66	8.4	20.11	5.5	131
0.59-0.81	C1	10YR 4/3	m 1 sbk	3.5	68.7	12.1	15.9	7.9	1.65	8.3	10.87	4.0	140
0.81-1.07	C2	10YR 4/3	m 2 sbk	3.5	75.9	10.8	13.5	6.5	1.66	8.4	10.30	2.0	149

Continued

Pedon - 5 : Fine-loamy, smectitic, hyperthermic Typic Haplustepts

0.00-0.13	Ap	10YR 4/3	m 2 sbk	22.8	35.6	35.7	27.4	14.8	1.49	8.2	34.48	5.5	144
0.13-0.33	Bw1	10YR 4/4	m 1 sbk	42.2	38.7	29.7	25.5	16.9	1.52	8.4	27.70	4.5	142
0.33-0.58	Bw2	10YR 4/4	m 1 sbk	26.6	42.6	30.1	27.5	14.9	1.54	8.3	28.21	3.3	162
0.58-0.88	BC	10YR 4/3	m 1 sbk	30.0	39.4	27.7	22.8	11.5	1.58	8.4	25.80	2.5	180
0.88-1.25	2C	10YR 4/3	m 1 sbk	15.0	52.7	18.0	17.4	9.8	1.60	8.4	17.11	1.6	183

Pedon - 6 : Very-fine, smectitic, hyperthermic Typic Haplusterts

0.00-0.15	Ap	10YR 3.5/2	m 1 sbk	2.8	04.7	67.2	46.3	28.2	1.74	8.3	64.10	7.5	149
0.15-0.44	Bw	10YR 3/2	m 3 sbk	3.5	03.2	71.6	48.5	30.4	1.77	8.4	66.05	3.9	159
0.44-0.75	Bss1	10YR 3/2	c 3 sbk	2.8	03.0	74.2	48.6	30.4	1.81	8.4	68.20	3.5	167
0.75-0.98	Bss2	10YR 3/2	c 3 sbk	2.8	02.8	75.0	48.7	29.8	1.83	8.4	73.30	3.2	153
0.98-1.26	Bss3	10YR 3/2	c 3 sbk	2.4	02.0	74.8	49.3	30.7	1.86	8.4	69.42	2.2	173

Pedon - 7 : Fine smectitic, hyperthermic Typic Haplustepts

0.00-0.12	Ap	10YR 3/3	m 2 sbk	5.7	13.6	47.3	39.8	26.6	1.66	8.1	46.30	5.7	112
0.12-0.34	Bw1	10YR 3/3	m 2 sbk	7.1	11.9	49.8	40.0	24.0	1.71	8.2	48.20	4.2	137
0.34-0.65	Bw2	10YR 3/3	m 3 sbk	7.1	12.1	52.3	40.7	24.0	1.74	8.2	51.10	1.7	138
0.65-0.96	Bw3	10YR 3/3	m 3 sbk	9.0	12.3	54.5	44.5	27.3	1.79	8.3	52.42	1.7	138
0.96-1.26	Bw4	10YR 3/3	m 3 sbk	7.2	13.7	47.3	42.5	28.6	1.69	8.2	47.12	1.5	161
1.26-1.33	Bw5	10YR 4/3	m 3 sbk	11.4	15.6	38.9	38.3	28.1	1.67	8.1	37.67	1.4	188

Pedon - 8 : Clayey over sandy, smectitic, hyperthermic Fluventic Haplustepts

0.00-0.15	Ap	10YR 5/3	m 2 sbk	5.7	34.1	36.2	27.0	15.6	1.62	8.2	34.25	8.7	100
0.15-0.40	Bw1	10YR 5/3	m 2 sbk	7.1	34.7	38.9	23.2	14.2	1.65	8.4	35.70	7.5	117
0.40-0.55	Bw2	10YR 5/3	m 2 sbk	4.2	40.4	39.3	21.2	12.7	1.69	8.3	33.30	6.0	122
0.55-0.67	Bw3	10YR 5/3	m 2 sbk	15.7	55.8	34.0	21.1	13.8	1.68	8.4	32.55	3.8	184
0.67-1.12+	2C	10YR 5/3	f 0 gr	2.5	83.6	09.2	05.2	03.7	1.68	8.4	08.70	2.7	174

within that depth and hence grouped under Fluventic sub-group (Soil Survey Staff 1998) of Haplustepts.

Soil-site characteristics and banana productivity

Banana is cultivated in irrigated environment and hence there is very little significance of rainfall and LGP. The temperature of 25.3°C (mean monthly) reported to be optimum for growth of banana is generally met in Wardha (26.5°C). However, extreme temperature (42°C to 45°C) sometime in the month of May/June adversely affect the growth due to intense desiccation caused due to high PET. High humidity (>60 per cent) is beneficial (Sys *et al.* 1993) and is maintained through frequent irrigations (furrow/drip) and by putting border line of castor/papaya or hedge. Banana prefers freely drained, deep and fertile loamy soils but it is cultivated on wide range of soil types following proper agromanagements. The soils are deep (>100 cm) but maximum feeder roots were confined to upper 45 cm depth in all the sites. Shanmugavelu *et al.* (1992) considered soils with 50 cm depth more suitable for banana cultivation. P1 and P6 pedons having high swelling clay and high bulk density appear to pose drainage problem thereby lowering the crop yields. Other pedons though have clay/clay loam texture at the surface, but have lighter sub-soil texture providing better drainage for root development and that resulted in higher productivity. The calcretes present as coarse fragments also help in improving the drainage. Banana grows well in pH range of 4.5 to 8.2 and the pH ranges (7.9 to 8.4) in the present study was found reasonably good for banana which had an added advantage of restricting occurrence of banana wilt. However, the presence of pH (7.9 to 8.4) may interfere with availability of some micronutrients more particularly of Zn. Sporadic deficiency of Zn was noticed in orchards by Kadao *et al.* (2002).

Considering the resources offered by the present study and requirement of banana for Central India (based on literature and productivity), pedon 8 rated as highly suitable (S1), pedons 2, 3, 4, 5 and 7 moderately suitable (S2) and pedon 1 and 6 as marginally suitable.

References

Dagde, V.G. (1986). Effect of graded level of nitrogen, phosphorus and potassium fertilization on growth, yield and nutrient status of Basrai banana. *Indian Journal of Agricultural Chemistry* **12**, 1-7.

Das, P.K. and Mohan, N.K. (1993). Effect of micronutrient on growth and development of banana. *South Indian Horticulture* **41**, 192-197.

Jackson, M.L. (1973) *'Soil chemical analysis'*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jeyabaskaran, K.J., Pandey, S.D., Mustafa, M.M. and Sathiamoorthy, S. (2001). Effect of different organic manures with graded levels of inorganic fertilizers on ratoon of *Poovan* banana. *South Indian Horticulture* **49**, 105-108.

Kadao, S.H., Prasad, J. and Gajbhiye, K.S. (2002). Micronutrient status in banana growing soils of Wardha district, Maharashtra. *Journal of Maharashtra Agricultural Universities* **27**, 117-118.

Palaniappan, R. and Yerriswamy, K.M. (1996). Effect of saline water irrigation on growth, yield and quality of *Robusta* banana. *Journal of the Indian Society of Soil Science* **44**, 143-146.

Shanmugavelu, K.G., Aravindakshan, K. and Sathiamoorthy, S. (1992). *Banana :* Taxonomy, breeding, and production technology. Metropolitan Book Co. Pvt.Ltd., New Delhi.

Sidhu, G.S., Deshmukh, S.N., Naidu, L.G.K. and Roychoudhary, C. (1989). Evaluation of Vertisols and associated soils for banana (*Musa paradisiaca L.*) cultivation in Jalgaon district of Maharashtra. *Indian Journal of Agricultural Sciences* **59**, 569-574.

Soil Survey Staff (1998). *Keys to Soil Taxonomy.* 8th Edition USDA Washington, D.C.

Srivastava, Rajeev, Gaikawad, S.T. and Jagat Ram (1991). Water retention characteristics of some swell-shrink soils of Chandrapur district of Maharashtra. *Agropedology,* **8**, 15-18.

Sys, Ir. C., Van Ranst, E., Debaveye, Ir. J. and Beernaert, F. (1993). *Land Evaluation,* Part III - Crop Requirements. Agricultural Publications No.7. General Administration for Development Cooperation, Place du Champ de Mars, 5 bte 57-1050, Brussels-Belgium, p.20-24.

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