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RESEARCH ARTICLE :

Land resources inventory of Jantapur-1 micro watershed Lingasugur taluk, Raichur district

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SUMMARY : Fourteen representative mapping units representing upland, midland, mid upland, lowland and near lowland in Jantapur-1 microwatershed of Lingasugur taluk, Raichur district in Karnataka were characterized and assessed for their nutrients content. The soils were shallow in upper slope and deeper in the lower slopes. Colour of the soil is reddish brown to very grayish brown, well, moderately to excessive drained, neutral to strong alkaline in reaction, low to medium in organic carbon and medium to high in cation exchange capacity with wide textural variations. Soils were low in available nitrogen, low to high in available phosphorus, potassium and sulphur. Whereas, copper, iron, manganese were sufficient but soils were deficient in zinc.

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KEY WORDS :
Soil resources, Soil survey, Soil characterization

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BACKGROUND AND OBJECTIVES

Watershed is a "geo-hydrological" entity or piece of land that drains at a common outlet. This natural unitis evolved through the interaction of the rainwater and land mass and normally comprises of arable and non-arable lands along with drainage lines. Thus, the watershed area is delineated based on distribution andflow of rainwater, which facilitates scientific developments of natural resources like soil, water and vegetation. The most important basic natural resource that determines the ultimate sustainability of any agricultural system is the soil. Jantapur-1 microwatershed in Raichur district of Karnataka was selected for this study as it has wide variety of soils. As the catchment area is an undulating terrain, it is quite likely that the land is subjected to different degrees of erosion resulting in varied depth of soils, making them fit for growing only a few set of crops. Keeping these factors in mind the study has been undertaken to characterize, classify and mapping the soils of Jantapur-1 microwatershed and to suggest the land use plan to protect the natural resources for sustainable crop production.

RESOURCES AND METHODS

Semi arid climate prevails on Jantapur-1 microwatershed and it belongs to North Eastern Dry zone of Karnataka state. The average annual rainfall is 765.54 mm. Mean maximum and minimum temperature is 34.50^0 C and 22.68 ^{0}C, respectively. The highest rainfall was received during the month of September (197.11 mm). The length of growing period, which indicates the availability of water for plant growth, is about 150 to 180 days in a year. It starts from the middle July and continues upto the end of December. The area qualifies for *Hyperthermic* temperature regime.

The purpose of the land resource inventory is to delineate areas, which respond for expected to respond similarly to a given level of management. This was achieved in Jantapur-1microwatershed by studying geo-morphological features (slope, surface stoniness, erosion, drainage, gravels etc.) of landscape and morphological features (soil depth, texture, colour, structure, consistency, course fragments porosity, soil reaction etc.) of the pedons. Based on these soil site characteristics of Jantapur-1 microwatershed area was divided into different homogenous units known as mapping / management units. The extent of area and distribution of these management units are marked with a boundary on Jantapur-1 cadastral map. The high intensity survey at 1: 8000 scale was carried out in 624.27 ha area of the Jantapur-1 during 2016.

OBSERVATIONS AND ANALYSIS

In red and black soil pedons, the bulk density varied from 1.40 to 1.52 Mg m^{-3} and1.24 to 1.33 Mg m^{-3}, respectively. In general, the bulk density of the lower solum was more than that of the upper. This could be attributed to clogging of pores by dispersed clays in sub-soil layers. Similar results were quoted by Pulakeshi *et al.* (2014) for the soils of Mantagani village of Haveri district in Karnataka. Similar findings were also reported by Yeresheemi *et al.* (1997) as well as Mruthunjaya and Kenchanagowda (1993) in Upper Krishna command and Vani Vilas command areas, respectively (Table 1).

The Porosity, in general, in red and black soil varied from 35.6 to 38.5 per cent and 49.6 to 53.2 per cent, respectively. Higher porosity was noticed in Heggapur series and lower porosity in Kumarkheda series. According to Brady and Weil (2002), ideal total pore space for crop production, is around 50 per cent. Thus, most of soil series in the study area had nearly acceptable range of total porosity values for crop production. These present findings are in line with those of Ashenafi *et al.* (2010).

In red soil pedon, the maximum water holding capacity of the soils ranged between 35.3 to 41.6 per cent. These differences were due to the variation in the depth, clay, silt and organic carbon content of soils. These results are in line with those of Thangasamy *et al.* (2005) in soils of Sivagiri village in Chittur district of Andhra Pradesh.

Whereas, in black soil pedons, the maximum water holding capacity ranged from 41.7 to 51.7 per cent. Maximum water holding capacity increased from surface to the lower horizons and followed the trend of clay content and these results are in line with those of Nagendra and Patil (2015). In general, black soil pedons possessed higher water holding capacity values than red soils (Challa and Gaikwad, 1987).

The pH of red soilswas neutral to slightly alkalinein reaction throughout the profile.In black soil series, the pH ranged from neutral to moderate alkaline in reaction. High pH in black soil pedons might be due to their calcareous nature and the accumulation of bases in the solum as they poorly leached (Satyanarayana and Biswas, 1970). In red soil pedons, large amount of bases have been leached out of the solum leaving behind iron and aluminium oxides and hence the pH in red soil pedons was less compared to their black soil. The pH increased with depth in both black and red soil pedons as the bases increased with depth.This may be ascribed to increasing content of exchangeable and soluble sodium and calcium with depth. Similar results were reported by Nagendra and Patil (2015).

In black and red soil series, the soluble salt content of the soils ranged from 0.19 to 0.43 dSm^{-1} and 0.12 to 0.16 dSm^{-1}, respectively. The soluble salt content generally increased with depth in black soils. The upper solum of black soils contained relatively low content than in the lower solum. This might be due to leaching of salts from the soil surface to lower depth due to rainfall or irrigation and their accumulation in lower depth. The soluble salt content was low in red soil compared to black soil, which indicated that red soil pedons were more leached compared to that of black soils. These results are in line with those of Goroji (1994) and Rudramurthy *et al.* (1996). Similar results were reported by Chandrasekhar *et al.* (2014).

Organic carbon content in red and black soil pedon series ranged from 1.80 to 4.79 g $kg^{-1}$and 2.39 to 5.79 g kg^{-1}, respectively. The organic carbon content decreased with depth in all the pedons. The lower contents of organic carbon apparently resulted because of high temperature which induced rapid rate of organic matter oxidation. These observations are in the line with the findings of Basavaraju *et al.* (2005) in soils of Chandragiri Mandal of Chittor district of Andhra Pradesh. Similar results were quoted by Kumar and Prasad (2010) and Mruthunjaya and Kenchanagowda (1993) in Vani Vilas command area.

The $CaCO_3$ content in red and black soil pedon series ranged from 4.52 to 5.82 per cent and 9.43 to 15.31 per cent, respectively. In black soils, $CaCO_3$ values were comparatively high than in red soilsand shown increasing trend with depth. Similar research report was also made by Satyanarayana and Biswas (1970) and Dasog (1975). The per cent free calcium carbonate in soils increased with depth; because, in semi-arid condition calcium and magnesium get precipitated as their carbonates and bicarbonates in the solum. The results obtained in present study are in agreement with the findings of Pramod and Patil (2015).

In red soils of Chatrathanda, Kumarkhed and Thodki series, the exchangeable calcium and magnesium was ranged from 18.12 to 20.87 cmol (p^+) kg^{-1} and 8.50 to 10.59 cmol (p^+) kg^{-1}, respectively. Whereas, in black soil series was ranged from 28.65 to 35.34cmol (p^+) $kg^{-1}$and 10.35 to 15.63cmol (p^+) kg^{-1}, respectively. It was clear that Mg^{+2} were present in low amount than Ca^{+2} because of its higher mobility. The low value of exchangeable monovalent compared to divalent was due to preferential leaching of monovalent than divalent. These findings are in accordance with Das and Roy (1979) (Table 2).

In red soil series, the exchangeable sodium and potassium was ranged from 1.22 to 3.47 cmol (p^+) kg^{-1} and 0.26 to 0.32cmol (p^+) kg^{-1}, respectively. Whereas, in black soil the exchangeable sodium and potassium in surface soils ranged from 3.11 to 3.71cmol(p^+) $kg^{-1}$and 0.40 to 0.68cmol (p^+) kg^{-1}, respectively. A measure of relative amounts of exchangeable sodium in comparison with the total cations in the soil are dependent on factors such as type of minerals, concentration of electrolytes and status of soluble cations (Sehgal *et al.*, 1968). These findings are in accordance with the works of Srinath (1979).

The dominant exchangeable cation in the soils was exchangeable calcium followed by exchangeable magnesium. The exchangeable sodium and potassium were low. There was a high degree of correlation between clay and CEC. Similar observation was made by Dasog and Patil (2011) in black, red and lateritic soils of Northern Karnataka. This is due to accumulation of clay and may be due to presence of smectic group of clay minerals (Pillai and Natarajan, 2004). Similar findings have been reported by Mruthunjaya and Kenchanagowda (1993) and Shadaksharappa *et al.* (1995) in Vani Vilas Command and Malaprabha Command, respectively.

The base saturation of all pedons was high in sub surface horizon than the surface. In most of the soils, the base saturation increased with the profile depth and was correlated to soil reaction. The increase in base saturation with the depth was due to the leaching of bases from the upper horizon and their accumulation in lower horizons. Similar results were reported by Sitanggang *et al*. (2006) as well as Ram and Govardhan (2011).

The per cent exchangeable sodium of both red and black soil pedons ranged from 3.9 to 6.9 and 6.6 to 7.9, indicating initiation of the process of solonization/ sodiumization in downward direction. A measure of relative amounts of exchangeable sodium in comparison with the total cations in the soil are dependent on factors such as type of minerals, concentration of electrolytes and status of soluble cations (Sehgal *et al.*, 1968). These findings are in accordance with the works of Srinath (1979); Deshpande (1985); Balpande *et al.* (1996) and Paliwal (1972).

In red soil series, the coarse sand, fine sand and total sand content ranged from 34.5 to 39.8, 22.8 to 27.1 and 57.2 to 64.1 per cent, respectively. Whereas, in black soil series, the coarse sand, fine sand and total sand content of the soil, respectively, ranged from 10.2 to 16.8, 18.4 to 27.0 and 29.0 to 42.7 per cent. This can be attributed to removal of finer fractions and consequent enrichment of sand fractions on the upper slopes. Similar research finding were reported by Vinay (2007) in Bhanapurmicrowatershed (Koppal district).

In red soils, the content of silt was in the range of 3.8 to 4.8 per cent. Whereas, in black soils, the distribution of silt was ranged from range of 8.1 to 14.2 per cent. In all the mapping units the silt content exhibited an increasing trend with depth of pedon (Table 3). These results were in agreement with the findings of Satish Kumar and Naidu (2012) in Vendamalapetamandal of Chittoor district, Andhra Pradesh.

In red soils, the clay content in the horizon ranged from 31.4 to 40.2 per cent. Whereas,in black soils, the clay content in the horizons ranged from 41.5 to 57.4 per cent. In all the mapping units the clay content increased with depth and this might be due to downward translocation of finer particles from the surface layers. Similar research finding is reported by Murthy (1988) in vertisols of India and this result in also in accordance with Pulakeshi *et al.* (2014) in northern transition zone of Karnataka.

Table 1 : Physico-Chemical properties of soil series of Jantapur-1 micro watershed

Mapping units	Horizon	Depth (cm)	BD Mg m^{-3}	Porosity	MWHC	pH (1:2.5)	EC (dSm^{-1})	OC (g kg^{-1})	Free $CaCO_3$ (%)
				%					
Kumarkhedseries red soil									
KMRfC2g2	Ap	0-14	1.43	37.9	35.3	7.11	0.12	1.80	4.52
	Apw	14-28	1.46	37.2	38.4	7.29	0.16	2.19	5.08
	B1	28-40	1.52	35.6	41.6	7.35	0.15	2.79	5.43
SWA			1.47	36.9	38.43	7.25	0.33	2.26	5.01
Thodki series red soil									
THDfC2g3	Ap	0-18	1.44	38.1	37.3	7.83	0.15	4.79	5.82
Chatrathandaseries red soil									
CHTfC2g1R2	Ap	0-22	1.40	38.5	36.4	7.24	0.14	2.00	4.61
Jantapurseries black soil									
JNTmB2g1	Ap	0-9	1.27	52.1	51.7	8.01	0.23	4.99	9.93
	Apw	9-28	1.29	51.3	48.0	8.19	0.26	4.39	10.35
	B1	28-45	1.30	50.9	45.8	8.31	0.32	3.79	11.17
SWA			1.28	51.43	48.5	8.17	0.27	4.39	10.48
Jantapurseries black soil									
JNTfC2g2	Ap	0-21	1.28	51.7	50.0	8.36	0.29	4.39	12.27
	B	21-39	1.31	50.6	49.8	8.49	0.35	4.19	11.76
SWA			1.29	51.15	49.9	8.43	0.32	4.29	12.01
Heggapur series black soil									
HEGmC2g2	AP	0-9	1.24	53.2	47.2	8.15	0.22	5.40	9.43
	Apw	9-22	1.26	52.5	44.4	8.25	0.26	4.39	10.28
	Bss1	22-40	1.29	51.3	46.7	8.47	0.28	3.99	11.08
	Bss2	40-60	1.31	50.6	42.7	8.56	0.34	3.39	11.32
	Bss3	60-72	1.33	49.8	40.8	8.21	0.33	2.99	12.17
SWA			1.28	51.48	44.36	8.33	0.28	4.03	10.85
Kalamalli series black soil									
KMLfC2g2S1	Ap	0-12	1.27	52.8	48.8	7.88	0.26	5.29	12.34
	Apw	12-29	1.29	51.3	46.2	8.13	0.29	4.19	12.93
	Bss1	29-50	1.30	50.9	45.1	8.29	0.32	3.59	13.78
	Bss2	50-78	1.32	50.2	44.6	8.41	0.35	3.39	14.15
	Bss3	78-100	1.33	49.8	42.4	8.55	0.43	2.79	15.31
SWA			1.30	50.86	45.42	8.25	0.34	3.91	13.70
Nagalapurseries black soil									
NAGmB2	Ap	0-18	1.26	52.5	46.9	8.15	0.19	5.39	11.71
	Apw	18-35	1.27	52.1	47.4	8.29	0.21	4.99	12.25
	Bss1	35-50	1.29	51.3	46.6	8.41	0.23	5.59	13.63
	Bss2	50-62	1.31	50.9	42.3	8.53	0.27	3.19	14.48
	Bss3	62-80	1.32	50.2	41.7	8.66	0.30	2.39	14.79
SWA			1.28	51.46	44.98	8.40	0.24	4.31	13.37

Note: SWA: Solum weighted average

Conclusion :

The pH of soils of Jantapur-1 micro-watershed ranged from 7.11 to 8.66 indicating that soils were neutral to moderate alkaline and free of salinity. Soils were low to high in organic carbon content which increases with depth. The texture of black soils was finer than red soils. In all the soils, clay and silt content was increased with depth, fine and coarse sand content was decreased with the depth. The bulk density of the sub surface layers was more than the surface layer. The maximum water

Table 2 : Exchangeable cations and cation exchange capacity of the soil series of Jantapur-1 micro watershed

Mapping unit	Horizon	Depth (cm)	Ca	Mg	Na	K	CEC	BS (%)	ESP
			cmol (p^+) kg^{-1}						
Kumarkhed series red soil									
KMRfC2g2	Ap	0-14	18.60	9.23	1.22	0.29	31.3	84.6	3.9
	Apw	14-28	19.49	9.85	2.15	0.31	33.5	85.5	6.4
	B1	28-40	20.87	10.59	3.47	0.26	36.8	87.8	6.9
SWA			19.65	9.89	2.28	0.29	33.80	85.96	6.73
Thodki series red soil									
THDfC2g3	Ap	0-18	18.12	8.50	2.79	0.27	30.3	85.3	6.2
Chatrathanda series red soil									
CHTfC2g1R2	Ap	0-22	18.50	10.10	1.31	0.32	31.1	87.2	4.2
Jantapurseries black soil									
JNTmB2g1	Ap	0-9	28.65	12.45	3.49	0.55	46.4	93.4	7.4
	Apw	9-28	30.45	13.24	3.50	0.53	48.5	94.3	7.3
	B1	28-45	31.70	14.65	3.59	0.51	51.2	94.8	7.0
SWA			30.26	13.44	3.54	0.53	48.83	94.16	7.23
Jantapur series black soil									
JNTfC2g2	Ap	0-21	31.55	10.35	3.51	0.50	46.8	94.0	7.5
	B1	21-39	32.29	10.98	3.69	0.47	48.9	94.9	7.6
SWA			31.92	10.66	3.60	0.49	47.80	94.45	7.55
Heggapur series black soil									
HEGmC2g2	AP	0-9	29.33	11.13	3.20	0.53	45.8	92.1	6.9
	Apw	9-22	29.75	11.65	3.53	0.49	47.2	94.1	7.9
	Bss1	22-40	31.86	12.79	3.57	0.44	49.4	94.4	7.3
	Bss2	40-60	32.45	13.50	3.63	0.42	51.3	95.5	7.2
	Bss3	60-72	33.24	14.35	3.71	0.40	52.7	96.2	7.0
SWA			31.32	12.68	3.53	0.45	49.28	94.46	7.26
Kalamalli series black soil									
KMLfC2g2S1	Ap	0-12	29.85	10.34	3.18	0.65	45.4	92.2	6.7
	Apw	12-29	31.25	11.45	3.24	0.68	47.3	93.9	6.8
	Bss1	29-50	31.75	12.35	3.45	0.63	49.8	94.1	7.6
	Bss2	50-78	32.96	13.79	3.51	0.59	52.5	94.5	7.3
	Bss3	78-100	33.25	13.73	3.67	0.58	54.3	94.9	7.1
SWA			31.81	12.33	3.43	0.63	49.86	93.92	7.10
Nagalapur series black soil									
NAGmB2	Ap	0-18	29.01	11.49	3.11	0.55	46.7	90.5	7.6
	Apw	18-35	32.53	12.67	3.20	0.51	49.2	91.1	7.3
	Bss1	35-50	33.15	13.87	3.32	0.49	51.6	90.2	7.2
	Bss2	50-62	34.51	14.14	3.42	0.47	53.9	92.2	6.9
	Bss3	62-80	35.54	15.63	3.49	0.45	55.2	93.3	6.8
SWA			30.32	11.96	3.30	0.49	51.32	91.46	7.16

Note: SWA: Solum weighted average

Table 3 : Particle size distribution of soil series of Jantapur-1 micro watershed

Mapping units	Horizon	Depth (cm)	Coarse sand	Fine sand	Total sand	Silt	Clay	Texture
					%			
Kumarkhed (B) series red soil								
KMRfC2g2	Ap	0-14	38.8	25.2	64.1	3.8	33.8	Sc
	Apw	14-28	36.0	24.3	60.2	4.4	37.5	Sc
	B1	28-40	34.4	22.8	57.2	4.6	40.2	Sc
SWA			36.40	24.10	60.50	4.26	37.16	Sc
Thodki series red soil								
THDfC2g3	Ap	0-18	39.8	23.8	63.8	4.8	31.4	Sc
Chatrathanda (A) series red soil								
CHTfC2g1R2	Ap	0-22	35.1	27.1	62.2	4.6	33.2	Sc
Jantapur (A) series black soil								
JNTmBC2g1	Ap	0-9	15.5	27.0	42.5	8.1	41.5	C
	Apw	9-28	13.4	24.8	38.2	9.3	43.4	C
	B1	28-45	11.2	25.7	36.9	10.8	48.8	C
SWA			13.36	25.83	39.20	9.40	44.56	C
Jantapur (A) series black soil								
JNTfC2g2	Ap	0-21	16.8	25.9	42.7	9.1	48.2	C
	B1	21-39	14.5	24.8	37.4	10.7	51.7	C
SWA			15.65	25.35	40.05	9.90	49.95	C
Heggapur (A) series black soil								
HEGmC2g2	AP	0-9	14.8	25.8	40.6	11.6	47.8	C
	Apw	9-22	13.2	24.5	37.8	13.2	49.0	C
	Bss1	22-40	12.7	22.5	35.2	13.6	51.2	C
	Bss2	40-60	12.1	20.5	32.6	14.2	53.2	C
	Bss3	60-72	11.4	19.4	30.8	13.8	55.4	C
SWA			12.84	22.54	35.40	13.35	51.32	C
Kalamalli series black soil								
KMLfC2g2S1	Ap	0-12	14.7	25.6	40.4	11.8	47.8	C
	Apw	12-29	13.2	25.1	38.4	12.0	49.6	C
	Bss1	29-50	12.4	22.3	34.8	12.6	52.6	C
	Bss2	50-78	11.7	20.3	32.0	13.2	54.8	C
	Bss3	78-100	10.2	19.4	29.6	13.7	56.6	C
SWA			12.46	22.54	35.04	12.68	52.28	C
Nagalapur series black soil								
NAGmB2	Ap	0-18	15.2	26.4	41.6	10.2	48.2	C
	Apw	18-35	13.9	24.1	38.0	10.6	51.4	C
	Bss1	35-50	11.8	23.6	35.4	11.6	53.0	C
	Bss2	50-62	11.1	21.5	32.6	12.2	55.2	C
	Bss3	62-80	10.3	18.8	29.0	13.6	57.4	C
SWA			12.46	22.88	35.32	11.64	53.04	C

Note: SWA: Solum weighted average

holding capacity of red and black soils varied. In black and red soil series shows increase in water holding with depth, because of increase in clay content. The calcium carbonate content increased with depth. Calcium and magnesium were the dominant exchangeable cations followed by sodium and potassium. Further CEC was also low to medium.

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