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Research Article
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Fertility status of soil along the water course of selected distributory-14 of Shahapur branch canal of UKP command area in Yadgir district of Karnataka

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Summary

The survey work was carried out during the year 2014-15 at Shahapur branch canal of Yadgir district, Karnataka and studied the fertility status of soil along the water course of canal command area. Available nitrogen content was comparatively more in sub surface soils than in surface soils all along the water course of distributory-14. Available phosphorus status in soils at the tail reach was comparatively more than that of head reach. Irrespective of surface and sub surface soils available potassium status was medium and was comparatively low in sub surface than in surface soils. However, increasing trend of potassium from head to tail via middle reach along the water course was observed. Available sulphur status was medium in surface and low in sub surface soils all along the water course. Available nitrogen, phosphorus, potassium and sulphur were strongly correlated with organic carbon (0.950, 0.989, 0.986 and 0.989), CEC (-0.841, -0.895, -0.934 and -0.946) and dehydrogenase activity (0.934, 0.979, 0.980 and 0.982). Higher concentration of DTPA extractable micronutrients namely, Fe, Cu and Zn in surface than in sub surface soils was observed all along the water course. However, fertility status of soils along the water course was low with respect to both available N and P, medium with respect to available K, S, Fe and Zn while high with respect to available Cu and Mn.

Key words : : Available macro, Micro nutrients, Organic carbon, Dehydrogenase activity

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Introduction

Fertile soil and irrigation are the two key factors for well flourished civilization and Mohenjo-Daro and Harappa in the Indus valley is the evident for it. At global level 20 per cent of total cultivated land is under irrigation and its contribution to the total food production of the world is 40 per cent and on an average crop yield from irrigated land is two times more than that of rain fed. Thus, irrigation continues to play an important role in contributing to the food and fibre production and is one of the vital factors to achieve food sufficiency at global level and India is also not exceptional for it.

Success of green revolution in India is mainly attributed to high yielding varieties accompanied by chemical fertilizers and irrigation. However, the success did not last long due to improper management of agricultural inputs and natural resources. Excessive use of chemicals and water for irrigation accompanied by excessive tillage, neglecting both organic manures and balanced integrated plant nutrition lead to deterioration of physical, chemical and biological properties and processes of soil which in turn decreased soil fertility and thereby drastic reduction in productive capacity of soils in command areas. Thus, present investigation on assessing the soil fertility status of red soils along the water course of selected laterals and distributory-14 of Shahapur branch canal in UKP command area of Yadgir was carried out to delineate the study area into different management units and to prepare thematic maps with respect to available nutrient status based on soil test values.

Resource and Research Methods

The area selected for the present study includes Shahapur and Shorapur taluks of Yadgir district and survey work was carried out during the year 2014-15 which is lies between North latitude 16°36'58.40'' to 16°74'11.63''and East longitude 76°38'04.99'' to 76°97'31.66'' along the water course of Shahapur branch canal of UKP command area. The study area is characterised by semi arid climatic condition, with the ten years average data of rainfall is 872.02 mm of which 74 per cent is received during south-west monsoon, 16 per cent during north-east monsoon and 8 per cent during summer season. The minimum temperature is recorded during December (15.68^{o}C) and maximum in May (40.33^{o}C). The maximum temperature remains between 29.91^{o}C to 35.33^{o}C from June to December. The mean relative humidity for forenoon and afternoon is 65.94 and 49.10 per cent, respectively. The mean monthly relative humidity is the highest in the month of September (81.33 %) and the lowest in March (46.84 %). At the head reach of SBC, the red soil area under paddy land use along the water course of distributory-14 was selected for the study and distributory-14 was divided into head, middle and tail sections. From each section of the distributory-14, one lateral was selected. Again each of these laterals was divided into head, middle and tail sections. Composite soil samples, one from each soil depths namely 0-20 and 20-40 cm were drawn from the three sub samples from the respective soil depths collected from the fields and each of these sub samples were from head, middle and tail reaches of each lateral. Thus, 18 soil samples were collected from the fields along the water course at the head reach of Shahapur branch canal and geographical position of the sampling spots were recorded using GPS. Collected soil samples were air dried in shade, ground in wooden pestle and mortar, passed through 2.00 mm sieve and the mineral matter left on the sieve was washed, dried, weighed and expressed as per cent gravels content of total soil. Processed soil samples were analysed for particle size classes, bulk density, available water, soil reaction organic carbon and dehydrogenase activity following standard procedures and however, soil samples were analysed for biological quality indicators within ten days from date of sampling.

Particle size analysis of soil was done by International pipette method (Piper, 1966) based on the principle of Stoke's law. Bulk density of soil was determined by core sampler method (Black, 1965). two composite soil core samples from each sections of the laterals at an interval of 0-20 and 20-40 cm soil depths were collected, using soil core samplers and these core samples were oven dried to constant weight. Based on the oven dried weight of soil core sample and volume of soil core sampler bulk density of soil was computed. Available water content of soil was determined by using pressure plate apparatus (Richards, 1954). Initially wet soil samples were drained to equilibrium at a suction of 1/3rd and 15 bars on 0.1 and 15 bar pressure plates, respectively. After attaining the equilibrium, soil sample weights were recorded immediately and kept in oven for dry. The differences in the water content between equilibrated wet soil and oven dried soil corresponding to the points of equilibrium at 1/3rd and 15 bar pressure were reported as water content at field capacity and wilting point, respectively. Available water content of soil was computed by taking the difference between the water contents at field capacity and wilting point.

Soil reaction was determined potentiometrically in 1:2.5 soil water suspension (Jackson, 1973). Organic carbon content of soil was determined by Walkley and Black's wet oxidation method (1934). Exchangeable potassium extracted by neutral normal ammonium acetate and was estimated flame photometrically (Jackson, 1973). Available nitrogen content of soil was determined by alkaline potassium permanganate method

(Subbaiah and Asija, 1956) using digestion cum distillation unit KELPLUS-CLASSIC DX (VA). Available phosphorus in soil was extracted by Olsen's extractant $NaHCO_3$ (Jackson, 1973) and the intensity of blue colour of phosphorus in the extract developed by stannous chloride was measured at 660 nm using spectrophotometer. Available sulphur in the soil was extracted using 0.15 per cent calcium chloride reagent as outlined by Jackson (1973). The sulphur in the extract was estimated by turbidometric method using $BaCl_2$ as stabilizing agent. The $BaSO_4$ turbidity was measured using spectrophotometer at 420 nm. Available micronutrients *viz*., Fe, Mn, Cu and Zn present in soil were extracted by Diethylene triamine penta acetic acid (DTPA) as per the procedure outlined by Lindsay and Norvell (1978).

Dehydrogenase activity of soil was determined as per the procedure outlined by (Casida *et al*., 1964). Soil with triphenyl tetrazolium chloride (TTC) was incubated for specific period and then shaken with methanol. The intensity of red colour developed due to the formation of Triphenyl formazon (TPF) was measured at 485 nm in spectrophotometer. Available nutrients were subjected to Pearson's correlation with soil properties to know the impact of soil properties on available nutrients status as the soil properties are influenced by continuous irrigation and land use for more than 30 years.

Research Findings and Discussion

Soil texture (Table 1) was slightly gravelly sandy loam in surface and gravelly sandy loam in sub surface soils all along the water course similar kind of observation recorded by Pandey and Singh (2015). Soil bulk density was comparatively more in sub surface than in surface soils all along the water course and similarly available water content of soils increased with depth all along the water course and from head to tail reaches via middle reach of distributory-14. Similar kind of observations was noticed by Thangasamy *et al.* (2005). Irrespective of head, middle and tail reaches of water course along the laterals of distributory-14, sub surface soils recorded the highest pH as compared to surface soils and however, soils were neither saline nor sodic as the pH of soils was in between 6.5 to 7.5 and these findings are in agreement with the findings of Prasad and Govardhan (2011) and Adejumobi *et al.* (2014). Electrical conductivity of soils was less than 4 dS m^{-1} along the water course in both surface and sub surface of distributory-14 and thus, soils were non-saline. Organic matter content was comparatively more in surface than in sub surface soils of distributory-14 and however, fertility status of soils with respect to organic matter was medium in surface and low in sub surface soils. Dehydrogenase activity also followed the trend of organic carbon with depth as well as along the water course (Table 2).

Nitrogen (N) :

In general available nitrogen content in soils all along the water course was low and this could be attributed to rapid oxidation of organic matter as climate is tropical. Comparatively more available nitrogen in subsurface soils (167.24 to 178.51 kg/ha) than in surface soils (144.93 to 155.13 kg/ha) at head, middle and tail reaches of distributory-14 and this could be attributed to both low organic carbon content and low activity of dehydrogenase at subsurface as compared to surface soils and it was further supported by the strong correlation available nitrogen with both organic carbon (0.950) and dehydrogenase activity (0.934) (Table 3). However, available nitrogen content all along the water course was almost same as present land use all along water course of distributory-4 was paddy. Tukura *et al.* (2013) also observed lower content of available nitrogen in soils at head reach as compared to that of tail reach.

Phosphorus (P_2O_5) :

Comparatively more available phosphorus in surface (23.85 to 24.96 kg/ha) and subsurface (17.49 to 18.27 kg/ha) soils of tail reach as compared that of head reach surface (21.99 to 22.52 kg/ha) and subsurface (16.46 to 17.23 kg/ha) soils of distributory-14 (Table 3) could be attributed to transportation of phosphorus along with finer soil particles through water erosion from head to tail reach against slope gradient and lower available phosphorous at sub surface as compared to that of surface could be attributed to immobile nature of P_2O_5. Similar kind of observations was reported by Tukura *et al.* (2013).

Potassium (K_2O) :

Irrespective of surface and sub surface soils available potassium status was medium and was comparatively less in sub surface (185.01 to 195.61 kg/ha) than in surface soils (270.36 to 287.16 kg/ha) as potassium is less mobile in soil. However, increasing trend of potassium from head to tail *via* middle reach along the water course of distributory-14 could be attributed

Table 1 : Particle size distribution in fine earth and whole soil (%) along the water course of diostributory-14

Particle size class	Distributory 14 / Laterals	Head: Latitude	Head: Longitude	Head: 0-20	Head: 20-40	Middle: Latitude	Middle: Longitude	Middle: 0-20	Middle: 20-40	Tail: Latitude	Tail: Longitude	Tail: 0-20	Tail: 20-40
		Lateral-4				Lateral-8				Lateral-12			
Coarse	Head	$16^0$72'06.94"	$76^0$94'21.83"	12.17	14.45	$16^0$72'76.92"	$76^0$95.42.93"	11.74	14.34	$16^0$74'14.75"	$76^0$96'70.28"	11.36	14.20
fragments	Middle	$16^0$72'09.80"	$76^0$94'13.76"	11.79	14.30	$16^0$72'74.46"	$76^0$95.65.60"	11.47	14.12	$16^0$74'09.12"	$76^0$96'99.79"	11.21	13.92
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	11.38	14.18	$16^0$72'89.45"	$76^0$95.71.33"	11.30	13.95	$16^0$74'11.63"	$76^0$97'31.66"	11.11	13.57
	Mean			11.78	14.31			11.50	14.14			11.23	13.90
Coarse	Head	$16^0$72'06.94"	$76^0$94'21.83"	49.40	46.17	$16^0$72'76.92"	$76^0$95.42.93"	49.40	46.03	$16^0$74'14.75"	$76^0$96'70.28"	49.20	45.79
sand	Middle	$16^0$72'09.80"	$76^0$94'13.76"	49.34	45.93	$16^0$72'74.46"	$76^0$95.65.60"	49.27	45.77	$16^0$74'09.12"	$76^0$96'99.79"	49.15	45.56
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	49.22	45.72	$16^0$72'89.45"	$76^0$95.71.33"	48.96	45.60	$16^0$74'11.63"	$76^0$97'31.66"	48.93	45.46
	Mean			49.32	45.94			49.21	45.80			49.09	45.60
Fine	Head	$16^0$72'06.94"	$76^0$94'21.83"	18.74	18.17	$16^0$72'76.92"	$76^0$95.42.93"	18.64	17.75	$16^0$74'14.75"	$76^0$96'70.28"	18.50	17.53
sand	Middle	$16^0$72'09.80"	$76^0$94'13.76"	18.63	17.95	$16^0$72'74.46"	$76^0$95.65.60"	18.45	17.51	$16^0$74'09.12"	$76^0$96'99.79"	18.40	17.39
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	18.35	17.49	$16^0$72'89.45"	$76^0$95.71.33"	18.38	17.23	$16^0$74'11.63"	$76^0$97'31.66"	18.23	17.25
	Mean			18.57	17.87			18.49	17.50			18.38	17.39
Total	Head	$16^0$72'06.94"	$76^0$94'21.83"	68.14	64.34	$16^0$72'76.92"	$76^0$95.42.93"	68.04	63.78	$16^0$74'14.75"	$76^0$96'70.28"	67.70	63.32
sand	Middle	$16^0$72'09.80"	$76^0$94'13.76"	67.97	63.88	$16^0$72'74.46"	$76^0$95.65.60"	67.72	63.28	$16^0$74'09.12"	$76^0$96'99.79"	67.55	62.95
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	67.57	63.21	$16^0$72'89.45"	$76^0$95.71.33"	67.34	62.83	$16^0$74'11.63"	$76^0$97'31.66"	67.16	62.71
	Mean			67.89	63.81			67.70	63.30			67.47	62.99
Silt	Head	$16^0$72'06.94"	$76^0$94'21.83"	15.56	15.70	$16^0$72'76.92"	$76^0$95.42.93"	15.66	15.97	$16^0$74'14.75"	$76^0$96'70.28"	15.76	16.01
	Middle	$16^0$72'09.80"	$76^0$94'13.76"	15.67	15.80	$16^0$72'74.46"	$76^0$95.65.60"	15.86	16.07	$16^0$74'09.12"	$76^0$96'99.79"	15.96	16.24
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	15.86	16.17	$16^0$72'89.45"	$76^0$95.71.33"	15.98	16.24	$16^0$74'11.63"	$76^0$97'31.66"	16.05	16.35
	Mean			15.70	15.89			15.83	16.09			15.92	16.20
Clay	Head	$16^0$72'06.94"	$76^0$94'21.83"	16.30	20.02	$16^0$72'76.92"	$76^0$95.42.93"	16.33	20.29	$16^0$74'14.75"	$76^0$96'70.28"	16.46	20.67
	Middle	$16^0$72'09.80"	$76^0$94'13.76"	16.36	20.32	$16^0$72'74.46"	$76^0$95.65.60"	16.45	20.64	$16^0$74'09.12"	$76^0$96'99.79"	16.57	20.81
	Tail	$16^0$72'13.83"	$76^0$93'92.98'	16.57	20.62	$16^0$72'89.45"	$76^0$95.71.33"	16.64	20.89	$16^0$74'11.63"	$76^0$97'31.66"	16.80	20.94
	Mean			16.41	20.32			16.47	20.61			16.61	20.81

Water course sections/reaches: Head, Middle, Tail; Coordinates (Latitude, Longitude); Soil depth (cm) (0-20, 20-40).

Table 2 : Physical and chemical properties of soil along the water course of distributory-14

Chemical quality indicators	Water course sections/reaches Distributory-14 / Laterals	Head				Middle				Tail			
		Co-ordinates		Soil depth (cm)		Co-ordinates		Soil depth (cm)		Co-ordinates		Soil depth (cm)	
		Latitude	Longitude	0-20	20-40	Latitude	Longitude	0-20	20-40	Latitude	Longitude	0-20	20-40
		Lateral-4				Lateral-8				Lateral-12			
Bulk	Head	16^{0}72'06.94"	76^{0}94'21.83"	1.49	1.58	16^{0}72'76.92"	76^{0}95.42.93"	1.48	1.58	16^{0}74'14.75"	76^{0}96'70.28"	1.48	1.57
density	Middle	16^{0}72'09.80"	76^{0}94'13.76"	1.49	1.58	16^{0}72'74.46"	76^{0}95.65.60"	1.48	1.57	16^{0}74'09.12"	76^{0}96'99.79"	1.47	1.57
(Mg m^{-3})	Tail	16^{0}72'13.83"	76^{0}93'92.98'	1.48	1.57	16^{0}72'89.45"	76^{0}95.71.33"	1.47	1.56	16^{0}74'11.63"	76^{0}97'31.66"	1.47	1.56
	Mean			1.49	1.58			1.48	1.57			1.47	1.57
AW	Head	16^{0}72'06.94"	76^{0}94'21.83"	7.67	8.54	16^{0}72'76.92"	76^{0}95.42.93"	7.78	8.73	16^{0}74'14.75"	76^{0}96'70.28"	7.95	8.88
(%)	Middle	16^{0}72'09.80"	76^{0}94'13.76"	7.91	8.78	16^{0}72'74.46"	76^{0}95.65.60"	8.06	9.03	16^{0}74'09.12"	76^{0}96'99.79"	8.18	9.07
	Tail	16^{0}72'13.83"	76^{0}93'92.98'	8.11	9.00	16^{0}72'89.45"	76^{0}95.71.33"	8.17	9.20	16^{0}74'11.63"	76^{0}97'31.66"	8.35	9.33
	Mean			7.90	8.77			8.00	8.99			8.16	9.09
pH_w	Head	16^{0}72'06.94"	76^{0}94'21.83"	7.07	7.28	16^{0}72'76.92"	76^{0}95.42.93"	7.04	7.22	16^{0}74'14.75"	76^{0}96'70.28"	7.09	7.33
(1:2.5)	Middle	16^{0}72'09.80"	76^{0}94'13.76"	7.08	7.30	16^{0}72'74.46"	76^{0}95.65.60"	7.06	7.25	16^{0}74'09.12"	76^{0}96'99.79"	7.15	7.39
	Tail	16^{0}72'13.83"	76^{0}93'92.98'	7.16	7.37	16^{0}72'89.45"	76^{0}95.71.33"	7.39	7.65	16^{0}74'11.63"	76^{0}97'31.66"	7.33	7.58
	Mean			7.10	7.31			7.16	7.37			7.19	7.44
CEC	Head	16^{0}72'06.94"	76^{0}94'21.83"	13.33	16.28	16^{0}72'76.92"	76^{0}95.42.93"	13.63	16.58	16^{0}74'14.75"	76^{0}96'70.28"	13.95	16.80
{cmol (P^{+}) kg^{-1}}	Middle	16^{0}72'09.80"	76^{0}94'13.76"	13.57	16.46	16^{0}72'74.46"	76^{0}95.65.60"	13.84	16.76	16^{0}74'09.12"	76^{0}96'99.79"	14.18	17.13
	Tail	16^{0}72'13.83"	76^{0}93'92.98'	13.72	16.68	16^{0}72'89.45"	76^{0}95.71.33"	13.96	17.00	16^{0}74'11.63"	76^{0}97'31.66"	14.46	17.58
	Mean			13.54	16.47			13.81	16.78			14.20	17.17
Organic carbon	Head	16^{0}72'06.94"	76^{0}94'21.83"	4.02	2.94	16^{0}72'76.92"	76^{0}95.42.93"	3.82	2.84	16^{0}74'14.75"	76^{0}96'70.28"	4.31	3.33
(g kg^{-1})	Middle	16^{0}72'09.80"	76^{0}94'13.76"	4.02	2.94	16^{0}72'74.46"	76^{0}95.65.60"	4.12	2.94	16^{0}74'09.12"	76^{0}96'99.79"	4.41	3.23
	Tail	16^{0}72'13.83"	76^{0}93'92.98'	4.31	3.23	16^{0}72'89.45"	76^{0}95.71.33"	4.41	3.33	16^{0}74'11.63"	76^{0}97'31.66"	4.70	3.53
	Mean			4.12	3.04			4.12	3.04			4.47	3.36
Dehydrogenase	Head	16^{0}72'06.94"	76^{0}94'21.83"	17.23	13.28	16^{0}72'76.92"	76^{0}95.42.93"	17.28	13.66	16^{0}74'14.75"	76^{0}96'70.28"	18.41	14.26
activity	Middle	16^{0}72'09.80"	76^{0}94'13.76"	17.75	13.72	16^{0}72'74.46"	76^{0}95.65.60"	18.62	14.26	16^{0}74'09.12"	76^{0}96'99.79"	19.39	14.66
(mg TPF kg^{-1} 24^{-}	Tail	16^{0}72'13.83"	76^{0}93'92.98'	19.15	14.39	16^{0}72'89.45"	76^{0}95.71.33"	19.39	14.66	16^{0}74'11.63"	76^{0}97'31.66"	20.77	15.66
^{1}hr)	Mean			18.04	13.80			18.83	14.19			19.77	14.86

Table 3 : Distribution of available macro nutrients in soils along the water course of distributory-14

Macro nutrients	Water course sections/reaches — Distributory 14 / Laterals	Head Co-ordinates Latitude	Head Co-ordinates Longitude	Head Soil depth (cm) 0-20	Head Soil depth (cm) 20-40	Middle Co-ordinates Latitude	Middle Co-ordinates Longitude	Middle Soil depth (cm) 0-20	Middle Soil depth (cm) 20-40	Tail Co-ordinates Latitude	Tail Co-ordinates Longitude	Tail Soil depth (cm) 0-20	Tail Soil depth (cm) 20-40
		Lateral-4				Lateral-8				Lateral-12			
Available	Head	16°72'06.94"	76°94'21.83"	140.67	160.40	16°72'76.92"	76°95.42.93"	148.53	168.53	16°74'14.75"	76°96'70.28"	151.20	173.80
Nitrogen	Middle	16°72'09.80"	76°94'13.76"	144.13	169.73	16°72'74.46"	76°95.65.60"	152.27	176.00	16°74'09.12"	76°96'99.79"	154.80	176.40
(kg ha^{-1})	Tail	16°72'13.83"	76°93'92.98'	150.00	171.60	16°72'89.45"	76°95.71.33"	157.47	185.33	16°74'11.63"	76°97'31.66"	159.40	185.33
	Mean			144.93	167.24			152.76	176.62			155.13	178.51
Available	Head	16°72'06.94"	76°94'21.83"	21.99	16.46	16°72'76.92"	76°95.42.93"	23.27	16.91	16°74'14.75"	76°96'70.28"	23.85	17.49
P_2O_5	Middle	16°72'09.80"	76°94'13.76"	22.42	16.93	16°72'74.46"	76°95.65.60"	23.85	17.49	16°74'09.12"	76°96'99.79"	24.38	17.86
(kg ha^{-1})	Tail	16°72'13.83"	76°93'92.98'	22.52	17.23	16°72'89.45"	76°95.71.33"	24.15	17.96	16°74'11.63"	76°97'31.66"	24.96	18.27
	Mean			22.31	16.87			23.76	17.45			24.40	17.87
Available	Head	16°72'06.94"	76°94'21.83"	267.48	182.48	16°72'76.92"	76°95.42.93"	276.16	183.88	16°74'14.75"	76°96'70.28"	281.08	193.72
(K_2O)	Middle	16°72'09.80"	76°94'13.76"	267.48	184.80	16°72'74.46"	76°95.65.60"	281.08	191.72	16°74'09.12"	76°96'99.79"	289.48	196.56
(kg ha^{-1})	Tail	16°72'13.83"	76°93'92.98'	276.12	187.76	16°72'89.45"	76°95.71.33"	281.08	191.72	16°74'11.63"	76°97'31.66"	290.92	196.56
	Mean			270.36	185.01			279.44	189.11			287.16	195.61
Available	Head	16°72'06.94"	76°94'21.83"	13.00	11.30	16°72'76.92"	76°95.42.93'	12.76	11.06	16°74'14.75"	76°96'70.28"	13.04	11.34
Sulphur	Middle	16°72'09.80"	76°94'13.76"	13.08	11.42	16°72'74.46"	76°95.65.60'	12.88	11.18	16°74'09.12"	76°96'99.79"	13.12	11.42
(mg kg^{-1})	Tail	16°72'13.83"	76°93'92.98'	13.20	11.54	16°72'89.45"	76°95.71.33'	13.12	11.42	16°74'11.63"	76°97'31.66"	13.20	11.46
	Mean			13.10	11.42			12.92	11.22			13.12	11.41

to the transportation of potassium along with water from head to tail reach against the slope gradient and accumulation of same in soils at tail reach. Similar kind of observations was reported by Finck and Venkateswarlu (1982).

Sulphur (S) :

Available sulphur status was medium in surface (13.10 to 13.12 mg/kg) and low in sub surface (11.22 to 11.42 mg/kg) soils of head, middle and tail reaches of distributory-14. Decreasing trend of available sulphur with depth could be attributed to the more of organic matter in surface than in sub surface and however, correlation studies indicated positively significant relation between organic matter and available sulphur (0.989). Increasing trend of available sulphur from head to tail reach laterals *via* middle reach could be attributed to transportation as well as seepage of available sulphur along with water from head to tail reach due to differences in elevation and these values are comparable to those reported by Balanagoudar and Satyanarayana (1990) in some Vertisols of North Karnataka.

Available micronutrients :

Comparatively higher concentration of DTPA extractable micronutrients namely, Fe, Cu and Zn in surface (1.73 to 2.78mg/kg), (0.88 to 1.38 mg/kg) and (0.47 to 0.59 mg/kg) than in sub surface (1.56 to 2.25 mg/kg), (0.59 to 0.86 mg/kg) and (0.35 to 0.45 mg/kg) soils along the water course of distributory-14 where these metallic cations decreased from head to tail reach and this could be attributed to less mobility and chelating of these metallic micro nutrients with organic matter as the organic matter content was more in surface and head reach soils than in sub surface and tail reach soils. Correlation co-efficient values were positive but non-significant for Fe, Cu and Zn were 0.371, 0.356 and 0.353, respectively in relation to organic matter (Table 4). These findings are in agreement with that of Ghafoor and Rasool (1999). Distribution of DTPA extractable Mn was same as that of iron copper and zinc with depth and reverse of these metallic cations along the water course.

Conclusion :

Primary available nutrients except nitrogen, phosphorus and potassium as well as the secondary

Table 4 : Distribution of available micro nutrients in soils (mg kg^{-1}) along the water course of distributory-14

Micro nutrients	Water course sections/reaches — Distributory 14 / Laterals	Head				Middle				Tail			
		Co-ordinates		Soil depth (cm)		Co-ordinates		Soil depth (cm)		Co-ordinates		Soil depth (cm)	
		Latitude	Longitude	0-20	20-40	Latitude	Longitude	0-20	20-40	Latitude	Longitude	0-20	20-40
		Lateral-4				Lateral-8				Lateral-12			
Iron	Head	16°72'06.94"	76°94'21.83"	2.28	1.83	16°72'76.92"	76°95.42.93"	1.74	1.60	16°74'14.75"	76°96'70.28"	2.35	2.13
	Middle	16°72'09.80"	76°94'13.76"	3.14	2.48	16°72'74.46"	76°95.65.60"	1.50	1.45	16°74'09.12"	76°96'99.79"	4.23	3.02
	Tail	16°72'13.83"	76°93'92.98'	2.19	1.83	16°72'89.45"	76°95.71.33"	1.95	1.64	16°74'11.63"	76°97'31.66"	1.75	1.60
	Mean			2.54	2.05			1.73	1.56			2.78	2.25
Manganese	Head	16°72'06.94"	76°94'21.83"	10.86	9.93	16°72'76.92"	76°95.42.93"	11.85	8.67	16°74'14.75"	76°96'70.28"	19.48	13.51
	Middle	16°72'09.80"	76°94'13.76"	22.86	20.11	16°72'74.46"	76°95.65.60"	7.11	6.27	16°74'09.12"	76°96'99.79"	9.82	8.31
	Tail	16°72'13.83"	76°93'92.98'	8.28	7.46	16°72'89.45"	76°95.71.33"	19.65	13.39	16°74'11.63"	76°97'31.66"	10.01	8.39
	Mean			14.00	12.50			12.87	9.44			13.11	10.07
Copper	Head	16°72'06.94"	76°94'21.83"	1.62	1.37	16°72'76.92"	76°95.42.93"	1.39	0.80	16°74'14.75"	76°96'70.28"	1.10	0.81
	Middle	16°72'09.80"	76°94'13.76"	1.13	0.49	16°72'74.46"	76°95.65.60"	1.46	1.22	16°74'09.12"	76°96'99.79"	0.60	0.46
	Tail	16°72'13.83"	76°93'92.98'	1.40	0.67	16°72'89.45"	76°95.71.33"	0.96	0.55	16°74'11.63"	76°97'31.66"	0.93	0.49
	Mean			1.38	0.84			1.27	0.86			0.88	0.59
Zinc	Head	16°72'06.94"	76°94'21.83"	0.57	0.40	16°72'76.92"	76°95.42.93"	0.57	0.41	16°74'14.75"	76°96'70.28"	0.50	0.37
	Middle	16°72'09.80"	76°94'13.76"	0.56	0.44	16°72'74.46"	76°95.65.60"	0.71	0.55	16°74'09.12"	76°96'99.79"	0.36	0.31
	Tail	16°72'13.83"	76°93'92.98'	0.45	0.35	16°72'89.45"	76°95.71.33"	0.48	0.39	16°74'11.63"	76°97'31.66"	0.54	0.38
	Mean			0.53	0.40			0.59	0.45			0.47	0.35

available nutrient sulphur showed decreasing trend with depth all along the water course of distributory-14 and nitrogen was more at sub surface than surface at head, middle and tail reach followed the trend same as that of rest of primary and secondary nutrients. Available micronutrients namely Fe, Mn, Cu and Zn were more in surface than in sub surface and it showed decreasing trend from head to tail reach with exception to that of Mn which showed the trend reverse to that of rest of micronutrients along the water course. Fertility status of both surface and sub surface soils along the water course was low with respect to both N and P, medium with respect to K, Fe and Zn, while high with respect to Cu and Mn. Sulphur status was medium in surface and low in sub surface soils.

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