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Fertility status of soils in Pamidimukkala mandal of Krishna district in Andhra Pradesh and their correlation studies

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Abstract

An investigation was carried out to study the fertility status of the soils in Pamidimukkala mandal of Krishna district, Andhra Pradesh. The study revealed that the pH of the soils ranged from 6.87 to 8.74, electrical conductivity from 0.22 to 2.64 dS m^{-1} and organic carbon from 0.38 to 1.21 %. Available nitrogen content of the study area varied from 193 to 351 kg ha^{-1} with a mean value of 267.08 kg ha^{-1}. The available phosphorus content of the soils ranged from 15.0 to 72.0 kg P_2O_5 ha^{-1} with a mean value of 43.73 kg P_2O_5 ha^{-1}. The available potassium content of soils ranged from 258 to 652 kg K_2O ha^{-1} with a mean value of 369.6 kg K_2O ha^{-1}. The availability of copper, iron and manganese in these soils was well above their critical limits, while the zinc was found to be below the critical limit in 25% of the samples. Correlation studies among different soil characteristics are also conducted to understand their relationship and influence among themselves.

Key words: Fertility status, micro nutrients, critical limit, correlation.

Introduction

As a result of green revolution cropping intensity throughout the country has greatly increased resulting in high stress on soil which is a non-renewable resource. On the other hand the population explosion has created great demand for food production from the limited available soil resources. Unscientific and excessive use of fertilizers, pesticides and cropping patterns are deteriorating the soil physical and chemical conditions resulting in lower crop yields even with higher inputs. The already available soil resource data is on large scale and most of it is at district level with less details, which cannot be followed at mandal and village level, particularly in the areas where the soil has great variation within small area. So, it is proposed to study the soil resources of Pamidimukkala mandal in Krishna district for their best use. Pamidimukkala is a typical and representative mandal of Krishna district where the major crops grown are paddy, sugarcane and blackgram. The nutrient status of the soils and their correlation studies are discussed to understand the soil nutrient status and also the interaction of different nutrients.

Material and Methods

The study area was categorized into two groups based on the cropping systems being practiced over decades. In one category, rice-pulse (rice-fallow black gram) cropping system is followed year after year, whereas in the other category the same cropping system is rotated with sugarcane after every 2-3 years, where soil and plant samples were collected and analyzed. The soils were heavy textured with mostly clayey texture. Forty soil samples, twenty under each category, were collected in the summer when fields were fallow and were analyzed for fertility status. Forty surface soil samples (0-15 cm) from representative locations were collected in Pamidimukkala mandal. Soil samples were air dried, ground, sieved through 2 mm sieve and then used for analysis. Both pH and EC of these samples were determined in 1: 2.5 soil water suspension, using glass electrode pH meter and Wheatstone conductivity bridge, respectively (Jackson, 1973). Organic carbon was determined by wet digestion method given by Walkley and Black (1934). Available nitrogen was determined by alkaline potassium permanganate method of Subbiah and Asija (1956). Available phosphorus was extracted with Olsen's extractant (0.5 M NaHCO3) and determined using ascorbic acid as the reducing agent (Watanabe and Olsen, 1965). Available potassium was extracted with neutral normal ammonium acetate and determined flame photo metrically (Jackson, 1973). Available Fe, Mn, Cu and Zn were extracted with DTPA extractant (pH 7.3) (Lindsay and Norvell, 1978) and determined by atomic absorption spectrophotometer. Correlation studies among different soil characteristics were carried out using the methodology suggested by Panse and Sukhatme (1978).

Results and Discussion

The pH of soil samples varied from 6.87 to 8.74 with a mean value of 7.99. According to classification given by the Department of Agriculture, Andhra Pradesh (1989), 12.5% of the samples were neutral (6.0-7.5), 70% were weakly alkaline (7.5-8.5) and 17.5% were tending to become alkali (8.5-9.0). The neutral and weakly alkaline nature of the soils might be due to their base rich nature and assured irrigation. The tendency to become alkali was observed in some soils which might be ascribed to bore well irrigation, containing more carbonates and bicarbonates. High clay content of the soils might have caused poor drainage of the soils resulting in salt accumulation in the surface resulting in increased soil pH. The results were in agreement with the findings of Sharma *et al.* (2008). The EC values of the soil samples varied from 0.22 to 2.64 dSm^{-1} with a mean value of 0.61 dSm^{-1}, indicating that the soils in this area were normal in respect of total soluble salt content excepting 5% of samples, which were found critical for germination of seed, according to the classification given by the Department of Agriculture, Andhra Pradesh (1989). The increase in salinity of some soils might be due to the impeded drainage conditions caused by high clay content and high water table of soils. Similar results were also reported by Surekha *et al.* (1997) and Leelavathi *et al.* (2009) in soils of Andhra Pradesh. The organic carbon content of the soils ranged from 0.38 to 1.21% with a mean value of 0.82% (Table1). Organic carbon content was found to be low (< 0.5 %) in 7.5% of the soils, medium (0.5-0.75%) in 35% of the soils and high (0.75%) in 57.5% of soils of the study area. Optimum levels of organic carbon, despite hot-humid conditions might be due to intensive cropping, regular addition of FYM and intermittent green manuring with sesbania, sunhemp and pillipesara during summer and during pre-kharif season. The results were in agreement with the

Table 1 : Soil physico-chemical properties and major nutrient status in Pamidimukkala mandal

S. No	pH	EC (dSm^{-1})	OC (%)	Nutrient status (kg ha^{-1}) N	P_2O_5	K_2O	S. No	pH	EC (dSm^{-1})	OC (%)	Nutrient status ($kgha^{-1}$) N	P_2O_5	K_2O
1.	8.47	0.49	0.94	286.0	32.0	578.0	21.	8.66	0.70	1.01	281.0	42.0	276.0
2.	7.71	0.66	0.73	236.0	15.0	377.0	22.	7.25	0.25	1.21	299.0	54.0	349.0
3.	8.18	0.70	0.97	295.0	39.0	394.0	23.	7.88	0.35	0.72	266.0	41.0	358.0
4.	7.67	0.53	0.98	321.0	42.0	386.0	24.	8.71	0.51	0.89	272.0	72.0	358.0
5.	8.36	0.44	0.58	193.0	47.0	415.0	25.	8.64	0.63	1.11	265.0	57.0	371.0
6.	8.20	0.41	0.94	281.0	38.0	381.0	26.	8.29	0.29	0.91	279.0	68.0	388.0
7.	6.87	0.55	0.66	264.0	52.0	374.0	27.	7.10	0.30	1.14	298.0	47.0	289.0
8.	7.85	1.59	1.09	302.0	56.0	389.0	28.	8.21	0.22	0.46	208.0	48.0	296.0
9.	7.77	0.63	0.88	240.0	28.0	424.0	29.	8.40	0.57	0.42	249.0	43.0	309.0
10.	7.79	0.38	0.64	259.0	36.0	341.0	30.	7.92	0.31	0.60	264.0	46.0	362.0
11.	8.66	0.24	0.58	281.0	27.0	414.0	31.	8.74	0.32	0.96	285.0	54.0	652.0
12.	7.76	0.51	0.79	243.0	54.0	384.0	32.	7.93	1.08	0.85	278.0	43.0	299.0
13.	7.05	0.28	0.55	241.0	50.0	355.0	33.	7.66	0.45	1.13	287.0	38.0	358.0
14.	8.09	0.56	0.66	256.0	58.0	415.0	34.	8.45	0.33	0.59	259.0	36.0	289.0
15.	8.15	0.51	0.38	235.0	20.0	274.0	35.	8.25	0.36	0.90	284.0	44.0	446.0
16.	7.24	0.59	0.68	221.0	53.0	327.0	36.	7.87	0.49	0.88	270.0	57.0	374.0
17.	7.79	0.25	0.54	208.0	39.0	381.0	37.	7.76	0.51	0.92	289.0	42.0	453.0
18.	8.62	0.93	0.97	281.0	34.0	258.0	38.	7.73	2.14	1.06	351.0	46.0	345.0
19.	8.18	0.65	0.66	234.0	28.0	278.0	39.	8.52	0.45	0.58	278.0	27.0	352.0
20.	7.73	2.64	1.16	306.0	55.0	398.0	40.	7.80	0.25	1.16	238.0	41.0	318.0

findings of Gopichand *et al.* (1985) in the soils of Andhra Pradesh (Table 1).

Available nitrogen content of the study area varied from 193 to 351 kg ha^{-1} with a mean value of 267.08 kg ha^{-1}. Based on the ratings give by Ramamoorthy and Bajaj (1969), 60% of the soils were low (<280 kg ha^{-1}) and 40% were medium (280-560 kg ha^{-1}) in available nitrogen content. Low available nitrogen content in these soils might be due to the crops previously grown *viz.,* paddy and sugarcane which were exhaustive feeders. Improper use of nitrogen fertilizers during previous crops in an unregulated water regimes might also have resulted in formation of more NO_3-N and its leaching into the deeper layers of soil leading to less available nitrogen in the surface soils. Similar results were reported by Suribabu (1999). The available phosphorus content of the soils ranged from 15.0 to 72.0 kg P_2O_5 ha^{-1} with a mean value of 43.73 kg P_2O_5 ha^{-1}. Among the samples analysed 2.5% were found to be low (<20 kg K_2O ha^{-1}), 67.5% were medium (20-50 kg K_2O ha^{-1}) and 30% were high (>50 kg K_2O ha^{-1}) in available phosphorus status. Medium to higher levels of available phosphorus in soils might be due to regular application of phosphatic fertilizers, organics and phosphate solubilising bacteria. The results were in accordance with the findings of Anitha *et al.* (2001). The available potassium content of soils ranged from 258 to 652 kg K_2O ha^{-1} with a mean value of 369.6 kg K_2O ha^{-1}(Table 1). Among the soils 20% were medium (150-300 kg K_2O ha^{-1}) and 80% were high (>300 kg K_2O ha^{-1}) in available potassium content. The high available potassium status of soils could be ascribed to application of FYM and other manures and application of potassium fertilizers during crop period duly following the method, time and dose of application. Besides that, minimized losses of potassium due to leaching might have contributed for high potassium status of the surface soils. Similar results were reported by Madhuvani *et al.* (2001).

The DTPA extractable copper, iron and manganese were found to range from 3.61 to 10.24, 13.86 to 97.10 and 18.44 to 48.19 ppm respectively and to be well above their critical limits of 0.2, 4.0 and 2.0 ppm respectively in all the samples. The available zinc ranged from 0.38 to 2.85 ppm (Table 2), with 75% of the samples having zinc levels above the critical level of 0.7 ppm and 25% below the limit (given by All India Coordinated Scheme on Micronutrients in Soils and plants, 1989). These findings were in concurrence with the findings of Ramprakash (1998) and

Table 2 : Micronutrient status in the soils of Pamidimukkala mandal

S.No.	Micronutrient status of soil (ppm)				S.No.	Micronutrient status of soil (ppm)			
	Cu	Zn	Fe	Mn		Cu	Zn	Fe	Mn
1.	8.20	0.76	38.42	27.64	21.	7.04	2.85	44.34	30.52
2.	7.22	0.58	29.50	26.72	22.	10.24	1.48	97.10	41.50
3.	4.68	0.52	54.94	26.16	23.	6.95	0.82	38.96	46.00
4.	8.62	0.68	33.02	41.30	24.	5.64	1.96	40.48	45.12
5.	4.60	0.94	17.10	23.34	25.	7.42	1.54	28.40	48.19
6.	7.26	0.40	26.20	25.54	26.	7.70	2.59	43.42	46.00
7.	9.18	0.80	56.22	42.00	27.	6.80	0.66	23.58	29.18
8.	7.26	1.26	13.86	39.04	28.	6.76	1.02	16.98	40.06
9.	9.18	0.88	33.56	46.94	29.	5.10	1.04	14.88	28.52
10.	9.12	0.86	26.26	18.44	30.	5.62	1.56	24.96	37.76
11.	7.54	2.14	26.12	41.86	31.	4.06	1.78	16.98	41.08
12.	5.70	1.02	33.12	41.92	32.	6.58	0.88	26.64	29.12
13.	6.76	0.98	63.22	43.00	33.	6.86	0.62	30.04	46.26
14.	5.82	1.66	25.52	41.72	34.	3.94	0.36	16.64	28.70
15.	8.32	0.60	21.00	28.38	35.	5.98	1.04	17.48	44.76
16.	7.73	0.81	28.36	34.23	36.	6.62	1.02	34.46	44.20
17.	4.76	0.64	23.72	40.18	37.	6.30	0.38	17.02	40.64
18.	7.02	0.88	52.34	45.00	38.	6.86	0.80	22.60	29.38
19.	3.16	1.62	25.34	32.76	39.	5.44	1.18	19.06	43.26
20.	6.24	1.30	41.42	43.00	40.	8.10	0.92	54.78	43.16

Table 3 : Correlation coefficients among different characteristics of soil

	O.C.	Av. N	Av. P	Av. K	Av. S	Cu	Zn	Fe	Mn	pH	EC	$CaCO_3$	B.D.	Ca	Mg	CEC	ESP
OC	1.0000	0.6617**	0.3072	0.1831	0.1757	0.2753	0.0944	0.3668**	0.2401	-0.1063	0.3685**	0.0917	-0.1814	0.1804	0.0332	0.1973	0.1644
Av. N		1.0000	0.1616	0.1802	0.1656	0.1963	0.0895	0.1571	0.0927	-0.0097	0.4659**	0.0856	-0.1546	-0.0069	-0.1416	-0.0167	0.0538
Av. P			1.0000	0.1428	0.2081	-0.0372	-0.4030**	0.1975	0.3860**	-0.0989	0.1178	0.0076	-0.3314	0.0256	-0.0293	-0.0717	0.2064
Av.K				1.0000	0.0587	-0.0675	0.0653	-0.1109	0.1530	0.1701	-0.0536	-0.1357	0.0417	-0.0967	-0.1190	-0.0815	-0.3833**
Av.S					1.0000	0.0062	0.0700	-0.1752	0.0595	-0.0778	0.3641**	0.2894	0.1780	0.0786	0.0365	0.0977	-0.1401
Cu						1.0000	0.0457	0.4685**	0.1164	-0.4201**	-0.0177	-0.3433**	-0.0299	0.3135**	0.2978	0.3292**	-0.1174
Zn							1.0000	0.1505	0.2993	0.4188**	-0.0152	-0.1636	-0.1829	-0.5160**	-0.4780**	-0.4783**	-0.0995
Fe								1.0000	0.2520	-0.3529**	-0.0572	-0.3955**	0.0182	0.0042	-0.0663	0.0200	-0.0582
Mn									1.0000	-0.0329	-0.0572	-0.2759	-0.2270	-0.0567	0.0102	-0.0547	0.1462
pH										1.0000	-0.0758	0.0834	-0.0638	-0.3761**	-0.3797**	-0.3943**	0.0181
EC											1.0000	0.4734**	0.2233	0.0705	-0.1502	0.0720	0.1661
$CaCO_3$												1.0000	0.1201	0.2377	0.1519	0.2540	0.2230
B.D.													1.0000	-0.0405	-0.1407	-0.0451	-0.1512
Ca														1.0000	0.9196**	0.9912**	0.1230
Mg															1.0000	0.8991**	0.1049
CEC																1.0000	0.0851
ESP																	**1.0000**

Correlation coefficients were calculated at 5% significance level

Madhuvani *et al.* (2001).

Correlation studies among soil characteristics helped in understanding the general relationship among different soil characteristics. The soil reaction has shown negative correlation (r = -0.0989) with the available P_2O_5, positive correlation (r = 0.1701) with the available K. The pH has negative and significant correlation with available iron content (r = -0.3529**) and available copper content (r = -0.4201**) but this negative correlation was non-significant with available manganese content (r = -0.0329). There was significant positive correlation between pH and available zinc (r = 0.4188**). Total soluble salts (EC) found to have negative correlation (r = -0.0177) with available copper, available manganese content (r = -0.0572) and with available iron content (r = -0.0572) of the soils. The organic carbon content of soils had shown significant positive correlation with available nitrogen content (r = 0.6617**) and available iron content (r = 0.3668**). The organic carbon has also shown positive correlations with available potassium (r = 0.1831), available copper (r = 0.2753) and available zinc (r = 0.0944) contents.

Available manganese (r = -0.2759), zinc (r = -0.1636), copper (r = -0.3955**) and iron (r = -0.3433**) showed a negative correlation with calcium carbonate content of the soils. The negative correlation was found significant in case of available iron and copper contents. There was positive correlation of manganese with other micronutrient contents *viz.,* zinc (r = 0.2993), copper (r = 0.1164) and iron (r = 0.2520). Positive correlations were found between available zinc and P_2O_5 contents (r=0.4030**), available copper and P_2O_5 contents (r=0.0372) and between available copper and CEC (r = 0.3292**) of the soils Correlation coefficients among soil properties are shown in table 3.

Available nitrogen has shown positive correlation (r = 0.0455) with grain yield of black gram. Grain yields of black gram was found to be positively correlated with available phosphorus (r = 0.3011) and available potassium (r = 0.0026) contents of soil. There

Table 4: Correlation coefficients (at 5% level) between soil nutrient status and blackgram performance

Nutrient	Nutrient uptake	Grain yield of black gram
Available N	0.0490	0.0455
Available P	0.3039	0.3011
Available K	0.1030	0.0026
Copper	-	0.2553
Zinc	-	0.2593
Iron	-	0.2468
Manganese	-	0.1114

was positive correlation of grain yield of black gram with available iron (r = 0.2468), zinc (r = 0.2593), copper (r = 0.2553) and manganese (r = 0.1114) of soil. Positive correlations were also found between soil available nitrogen, phosphorus and potassium with plant nitrogen uptake (r = 0.0490), phosphorus uptake (r = 0.3039) and potassium uptake (r = 0.1013) respectively. Correlation coefficients between soil nutrient status and black gram performance were given in Table 4.

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