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Research Article

Assessement Of Soil Quality Under Rice (*Oryza Sativa*) Cropping Systems, Yelamanchili Mandal, Visakhapatnam District, Andhra Pradesh, India

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ABSTRACT
Studies on soil quality assessment of physico-chemical and microbial growth parameters were investigated under rice (*Oryza sativa*) cropping systems of Yelamanchili mandal areas of Visakhapatnam district, Andhra Pradesh, India. Soil samples were collected during before cropping (B), middle cropping (M) and after cropping Periods (A). The study findings of soil analysis revealed that significant changes were observed in physico-chemical properties such as Soil Texture, pH, Organic Carbon (OC), Nitrogen (N), Phosphorous (P), Alkalinity, Acidity, Micronutrients (Cu & Zn) and total Microbial Counts (TMC). Soil Micronutrients of Copper (Cu), Zinc (Zn) and Microbial Growth were slightly in higher quantities during Middle cropping period (M). Correlation analysis showed that Micronutrients were moderate to highly correlate with each other and found to be increased in Middle cropping and decreased at Post cropping periods (A).

KEYWORDS: Soil Analysis; rice cropping systems; physico-chemical parameters; micro nutrients; microbial growth

INTRODUCTION

Soil is the most precious renewable natural resource and an important component of Earth's biosphere. The increase in population is putting a continuous pressure on soils leading to degradation and making them gradually unfit for cultivation of crops. The agriculture systems of India occupy an important position in global cultivation of rice, wheat, sugarcane, pulses, fruit crops and vegetables. In India the usage of chemical fertilizers has increased drastically impacts on soil fertility, nutrient imbalances and quality of environment. Thus without prior knowledge on status of soil fertility might have been resulted adverse effects on soils as well as crops both in terms of nutrient deficiency and toxicity either by adequate or over usage of fertilizers [11].

Hence, soil analysis is the way to explore and observe the available nutrient status in agriculture systems to develop sustainable management strategy for conservation of soils by applying organic fertilizers in cropping systems. The coastal regions highly productive in nature are under intensive cultivation of low land rice, several commercial and fruit crops. Recent surveys indicated that the crop production is

suffering due to problems in soils and inefficient management of fertilizer and pesticide inputs even though several technologies have been developed in recent years for adoption by farmers [10].

In view of above importance an attempt has been made to know the soil physico-chemical parameters and nutrients availability in rice growing areas of Yelamanchili mandal of Visakhapatnam district, Andhra Pradesh, India.

This study was aimed to compare the soil quality in different rice cropping periods with the following objectives:

1. To investigate the soil quality in relation to Physico-chemical parameters in rice cropping systems of Yelamanchili mandal of Visakhapatnam district, Andhra Pradesh.
2. To compare the variations in micronutrients and microbial growth rates before, middle and after cropping periods of rice cultivated areas for soil quality management.

MATERIALS AND METHODS

Description of Study area:

The study area Yelamanchili mandal is geographically situated between 17° 33'.6"N latitude and 82° 85'.41"E longitudes in south eastern part of Visakhapatnam district of Andhra Pradesh, India (Fig.1). The temperatures are recorded from 27.5°C to 32.0°C and mean annual rainfall is 100cm received from southwest and northeast monsoons. Rice (*Oryza sativa*) is the most abundant and extensively cultivated crop in low land areas of this region.

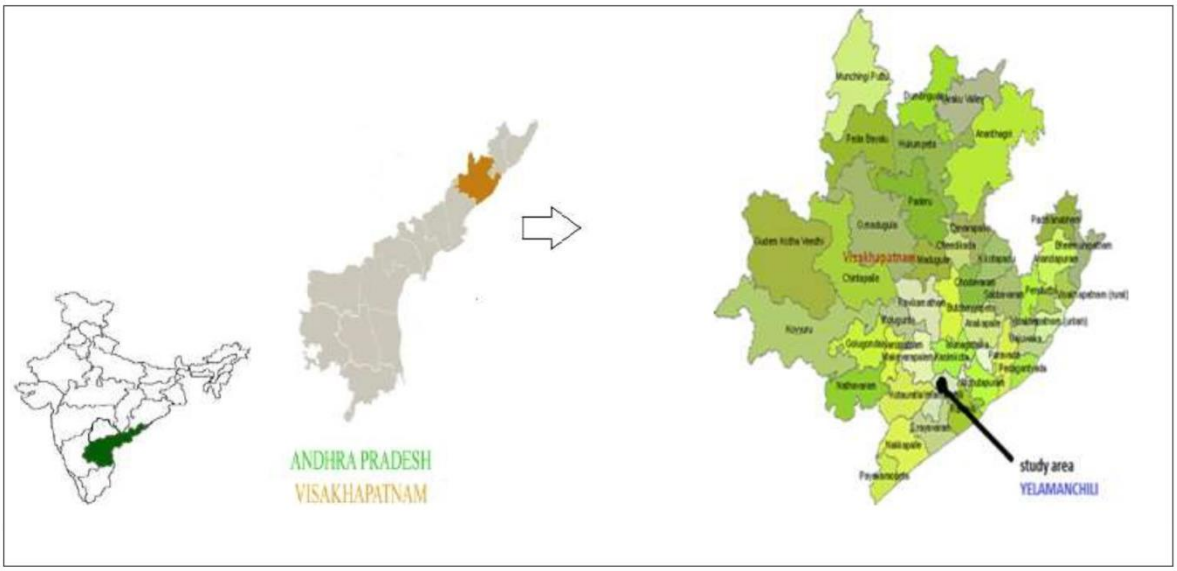

Fig. 1: Map showing the study area of Yelamanchili mandal, in Visakhapatnam district , Andhra Pradesh, India

Soil sample collection:

Soil samples were collected in rice cultivated areas of Yelamanchili (F1); Sytharupeta (F2); and Narayanpuram(F3) in three stages of before (B), middle (M) and after (A) cropping periods. The soil loams of 2x2cm from 5.0 to 10.0cm depth increments at randomly selected locations of rice fields with a sample size of twenty seven soil cores (B9n+M9n+A9n=27n) were collected into polythene bags marked with date and field stations (Fig.2). The details of field stations and collection of soil samples at different cropping periods are given in table 1:

Table 1: Details of collection of soil samples in three field stations and rice cropping periods

Field Stations	Yelamanchili (F1)	Sytharupeta (F2)	Narayanapuram (F3)	Cropping Period
Collection of Soil Samples	B1-3n	B2-3n	B3-3n	Before
	M1-3n	M2-3n	M3-3n	Middle
	A1-3n	A2-3n	A3-3n	After

Fig. 2: Collection of soil sample at rice field during the pre-cropping period

The collected soil samples were dried under the sun light then grinded by using mortar and sieved through 2mm mesh size sieves to obtain fine sand particles. The physico-chemical parameters like Soil texture (Silt, Clay and Sand), pH, Organic Carbon(OC), Nitrogen(N), Phosphorous(P) Alkalinity, Acidity, Zinc(Zn), Copper(Cu) and Total Microbial Count (TMC) were analyzed as per the standard methods of the following instruments as per the descriptions of table 2.

Table 2: Methods and Instruments used for analysis of soil samples in rice cropping systems

Parameter	Units	Methods and Instruments
P^H	-	pH-meter /ASTMD-4980
Soil Texture: (Sand, Silt and Clay	Percentage	Feel method -sieve method. Hand book of methods in environmental studies.
Organic Carbon	Percentage	USEPA- 415.1
Nitrogen as (N)	Percentage	Soil Chemical Analysis By Ml Jackson
Phosphorous as (P)	Mg/kg	USEPA 3050-B
Alkalinity	Mg/kg	APHA 2320 –B
Acidity	Mg/kg	APHA 2310- B
Zinc As (Zn)	Mg/kg	USEPA 3050 –B
Copper As (Cu)	Mg/kg	USEPA 3050 –B
Total Microbial Count (TMC)	CFU/ml	IS 5402 : 2012/COLONEY COUNTER

RESULTS AND DISCUSSION

Physico- Chemical Parameters:

The details analysis of Physico-Chemical parameters of Soil texture (Silt, Clay & Sand), pH**,** Organic Carbon (OC), Nitrogen(N), Phosphorous(P), Alkalinity, Acidity, Micronutrients of Zinc (Zn), Copper (Cu), and Total Microbial Counts (TMC) of the rice cropping systems of three field stations are presented in table 3.

Table 3: Analysis of Physico-chemical and Microbial growth parameters of soils under rice cropping systems of Yelamanchili mandal, Visakhapatnam district, Andhra Pradesh

S.No	Soil samples and Field stations	Before the crop(B)				Middle of the crop(M)				After the crop(A)			
		B1-F1	B2-F2	B3-F3	Mean	M1-F1	M2-F2	M3-F3	Mean	A1-F1	A2-F2	A3-F3	Mean
1	pH	7.44	7.56	7.34	7.44	7.58	7.69	7.56	7.61	7.66	7.84	7.69	7.73
2.	Texture (%) (i). Silt+ Clay (%)	65.6	66.4	67.36	66.47	70.4	71.36	72.56	71.44	60.4	70.24	69.63	66.75
	(ii). Sand (%)	34.4	33.55	32.64	33.53	29.6	28.64	27.44	28.56	35.6	29.76	30.37	31.91
3.	Organic Carbon (%)	0.87	0.89	0.90	0.88	0.93	0.98	0.96	0.95	0.72	0.76	0.87	0.78
4.	Phosphorous(P) mg/kg	0.032	0.028	0.040	0.033	0.008	0.009	0.010	0.009	0.011	0.012	0.025	0.016
5.	Nitrogen (N) (%)	0.568	0.635	0.598	0.600	0.263	0.459	0.337	0.353	0.316	0.525	0.425	0.422
6.	Alkalinity (mg/kg)	1300	1255	1350	1301	1800	1750	1780	1776	800	880	990	890
7.	Acidity(mg/kg)	-0.30	-0.28	-0.31	-0.29	- 0.15	-0.18	-0.21	-0.18	-0.35	-0.36	-0.33	-0.34
8.	Zinc (Zn) (mg/kg)	0.039	0.042	0.035	0.038	0.18	0.20	0.21	0.19	0.039	0.041	0.035	0.038
9.	Copper(Cu) (mg/kg)	0.0202	0.0209	0.0209	0.0206	0.015	0.018	0.019	0.017	0.020	0.0206	0.0204	0.0203
10	Total Microbial Count (CFU/ml)	92×10^{-2}	99 $x10^{-2}$	96×10^{-2}	95×10^{-2}	124×10^{-2}	133×10^{-2}	115×10^{-2}	124×10^{-2}	89×10^{-2}	115×10^{-2}	82×10^{-2}	95×10^{-2}

Collection of soil samples: B-Pre cropping period;M-Middle cropping and A-Post cropping stage.
Field Stations: F1 (Yelamanchili), F2 (Sytharupeta); F3 (Narayanapuram).

Soil Texture

Soils under study area were sandy to silt loam with a texture was characterised by abundance of silt and clay. Texture of soils gradually decreased before to middle cropping periods (66.47% to71.44%) due to tillage and ploughing after harvesting of the rice crop. However, sand content was gradually increased from middle (M) to after (A) cropping periods (28.56% to 33.53%) and highest amount of sand content was found before the cropping period (33.53%). These changes were also observed due to excessive usage of inorganic fertilizers over a period time on soil texture, silt and clay composition, practical size distribution were observed in rice cropping systems of south eastern Nigeria [9].

pH

pH can be referred to the degree of acidity and alkalinity in the soils. A little variation in the pH of the soils can have a significant change in the physico-chemical and biological properties. The optimum pH range required for crops is from 6.5 to 8.5 and present study shows that pH of soil samples was ranged between 7.4 and 7.8 which indicate slightly towards alkaline. The highest pH was found at F2 sample (7.84) after cropping period and lowest pH was observed at F3 sample (7.34) before cropping period. Variations in pH levels either very low or high indicates deficiency of nutrients, less performance of microbes, reduction in crop production and damage to the soil quality [4].

Organic Carbon (OC)

Organic carbon (OC) ranges from 0.78% to 0.95 % with a mean value of 0.87% in soil samples of all the three cropping periods. While lowest organic carbon was observed in F1 sample (0.72%) after (A) the cropping period and highest organic carbon was observed in F2 sample (0.98%) during middle (M) of the cropping. The lowest organic carbon content of soils resulted less diversity in soil biota and risk in soil physico-chemical environment [5].

Phosphorous (P)

Available phosphorus (P) ranges from 0.009 to 0.033 mg/kg with a mean of 0.019 mg/kg was found to be low in F1 soil sample (0.008 mg/kg) at middle (M) cropping. Highest concentration was observed in F3 soil sample (0.040 mg/kg) before (B) cropping period. Consistently the phosphorous content was observed in very low concentrations (0.009 mg/kg) during middle cropping period in all soil samples. This change may be due to the application of chemical fertilizers during cropping periods and only a

small amount of phosphate in runoff water can leachate is negligible agronomical but it could be often enough to make the water bodies eutrophic environmentally [6]

Nitrogen (N)

Nitrogen (N) concentration of soils was recorded from 0.263% to 0.635% with a mean percentage of 0.458% and highest amount of nitrogen (N) was observed in F2 station soils (0.635%) before(B) cropping and lowest percentage of nitrogen was recorded in F1 station soils (0.263%) during middle (M) stage due to inadequate supply of nitrogen (N) to F1 rice growing areas. Nitrogen (N) is the most important nutrient in rice production [3] and current high yields of rice are usually associated with large applications of fertilizers [1].

Alkalinity

Alkalinity range was from 800 to 1800 mg/kg with a higher mean value was observed in F1 soil sample (1776 mg/kg) during middle of the crop and lower values were recorded in all soil samples of F1 (800 mg/kg) F2 (880 mg/kg) and F3 (990 mg/kg) after the cropping period (A) with a mean value of 890 mg/kg.The retention of agricultural residues is an important practice to maintain soil fertility and redistribution of alkalinity [2].

Acidity

Acidity of soils was ranged from -0.18 to -0.34 mg/kg and slightly higher at F1 (-0.36) after (A3) cropping and lowest (-0.15mg/kg) in before (B1) cropping. Soil acidity can be naturally occurring and can be made worse by prolonged use of Ammonia (NH3) and Mono Ammonium Phosphate (MAP). Soil acidification is a major land degradation issue which can lead to reduced availability of nutrients with lower yields [8].

Micronutrients

Zinc (Zn)

Zinc (Zn) concentration with a mean value of 0.088 mg/kg and was found to be lowest in F3 soil samples (0.035mg/kg) before (B) cropping, where as highest Zinc (Zn) was recorded in F2 soil sample (0.21mg/kg) during middle (M) of the crop. It was evaluated that slightly high value of Zinc (Zn) was found during middle cropping (M) may be due to application of chemical fertilizers in middle stages of rice growth period [12].

Copper (Cu)

Copper (Cu) range was from 0.015 to 0.02mg/kg with a mean value of 0.019 mg/kg and lower concentration was found in F1 soil sample (0.015 mg/kg) during middle (M) cropping period and high value was found in F2 soil sample (0.026 mg/kg) after (A) the cropping period. Copper (Cu) concentrations below 0.8 mg/kg could indicate a deficiency due to plant growth resulted lowers the Copper (Cu) values during middle cropping periods [7]. The micronutrients variation at three cropping stages are shown in Fig.3

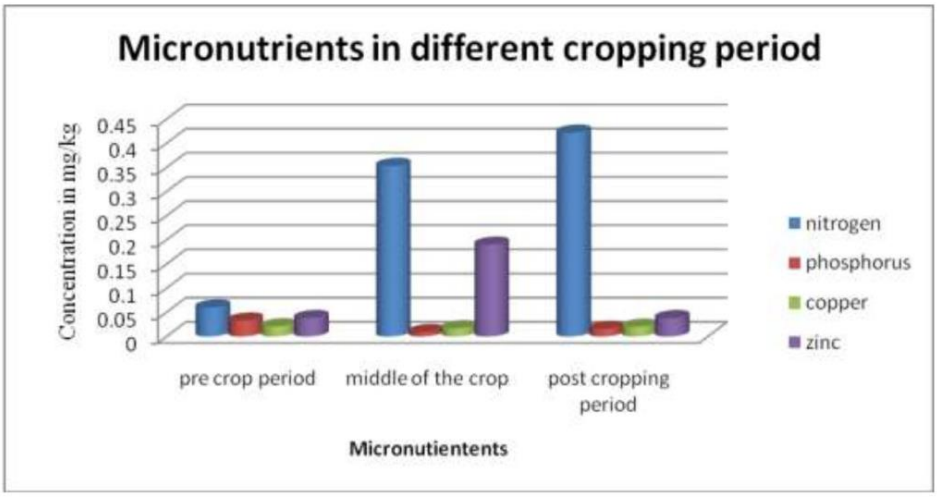

Fig. 3: Showing the variation of soil micronutrients in different cropping periods of rice cultivated areas

Total Microbial Count (TMC)

The total microbial count (TMC) of soil samples were range from 92×10^{-2} to 133×10^{-2} CFU/100ml with a mean of 101×10^{-2} CFU/100ml during middle (M) and after (A the crop periods. The observations shows that highest microbiological count was found during middle (M) of the crop ($115x10^{-2}$ CFU/100ml) and low count ($95x10^{-2}$ CFU/100ml) was recorded after (A) the cropping period. These changes are due to repeated fertilizer applications impact on the soil microbial community directly or indirectly as the soil microorganisms are involved in various biochemical processes and biological properties are vital in maintaining soil fertility and plant yields [13].

Correlation Analysis

In all the sampling periods the pH is negatively correlated with all other parameters and positively strongly correlated with micro nutrients like Zinc (0.018 mg/kg) and Organic Carbon (OC) was strongly correlated with Alkalinity, Acidity and Zinc (0.82 mg/kg). Phosphorous is highly correlated with Nitrogen and Copper, Nitrogen was negatively correlated with Alkalinity and Acidity. Zinc was strongly correlated with Copper (0.0814 mg/kg). The variation in all micronutrients is moderate to highly correlate with each other during the study period are shown in table 4.

Table 4: Correlation analysis of various chemical parameters of soil in rice field

	pH	Organic carbon	Phosphorous	Nitrogen	Alkalinity	Acidity	Zinc	Copper
pH	1							
Organic Carbon	-0.38035	1						
Phosphorous(P)	-0.70975	0.036599	1					
Nitrogen(N)	-0.19782	-0.10565	0.677483	1				
Alkalinity	-0.34432	0.909363	-0.22084	-0.36944	1			
Acidity	-0.14519	0.821176	-0.41773	-0.55093	0.949433	1		
Zinc (Zn)	0.181957	0.481726	-0.48512	-0.49535	0.602784	0.760824	1	
Copper(Cu)	-0.08144	-0.45637	0.612205	0.859462	-0.69506	-0.84661	0.8146	1

CONCLUSION

The results indicated that there was a significant variation in soil physico-chemical parameters, micronutrients and total microbial counts (TMC) at three cropping stages of rice cultivated systems. Analysis of soil micronutrients shows that moderately to highly correlate with each other. The study findings revealed that pH was in neutral to slightly alkaline, Organic carbon (OC) was in lowest levels and slightly increased during middle stages (M) of cropping period. The Nitrogen (N) and Phosphorus (P) values were below the required limits. The observed copper (Cu) and Zinc (Zn) in the tested soils were below to the required levels at three stages of cropping periods and were not sufficient for optimal crop growth.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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