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Assessing the Nutrient Status of Soil and Water Bodies in Palayapatti Areas, Thanjavur District of Tamil Nadu (India)

S. Selvaraj[1,2]

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ABSTRACT

Background: Thanjavur is a cauvery delta zone for paddy growing area of Tamil Nadu. The current study aiming with understanding about chemical properties and nutrient status of soils of selected area and assessing quality of water bodies.

Methods: The study was conducted during 2018-19 at Palayappatti and its surrounding villages in Thanjavur district of Tamil Nadu to find out the nutrient status of soil and water. Fifty representative soil samples and ten water samples collected with the objectives of analyzing chemical properties of soil and assessing water quality in Palayapatti and its surrounding villages of Thanjavur district.

Result: The collected soil and water samples varied with different chemical and physical properties. Soils were slightly acidic to slightly alkaline, normal EC and low organic carbon, low to medium content of nitrogen, phosphorus and potassium, low to medium content of calcium, magnesium and sulphur. Water samples were slightly acidic to moderately alkaline pH, medium to high salt content, moderate amount of carbonate and bicarbonate content. The soil and water bodies of this land having medium range of nutrients and also improvement is need in water quality.

Key words: Chemical properties, Soil, Water samples.

INTRODUCTION

Soil is the vital natural resource for the survival of life on the earth and its assessment is the prerequisite for the determination of productivity of soil and the sustainability of the ecosystem. The biggest challenge to the mankind today, is to provide the basic necessities for living, from the ever shrinking and non-renewable soil resource (Lal, 2013). Soils are considered as an integral part of the landscape and thus characteristics are largely governed by the landforms on which they have developed (Sharma *et al.,* 2014). Precise scientific information on characteristics, potentials, limitations and management of different soils are indispensible for planned development of soil resources to maintain their productivity and to meet the demands for the future.

The quality of ground water plays a key role in judging its suitability for crop production. Declining soil fertility and mismanagement of plant nutrients have made this task more difficult (Yaser and Rahim, 2013). Irrigation has been found to be beneficial in increasing productivity of land, provided all the conditions for irrigation suitability of particular land is optimum but if any one of the parameters is limiting, then irrigation may not be so sustainable (Mandal *et al.,* 2009). Water resources in Thanjavur district, Tamil Nadu are currently under serious pressure. The ground water usage in the district is in the range of 18 to 160%. The study is having objectives as to estimate the chemical properties and nutrient status of soils and to assessing quality of water bodies in selected areas.

MATERIALS AND METHODS

Ten villages are selected and soil and water samples collected in these villages by taking into consideration of geology, climatic conditions, geomorphic characters and other related pedological information pertaining to the study area. The study area of Palayapatti in Budalur taluk co-ordinated with 10°78′ N and 78°98′E.

Surface (0-15 cm) soil samples were collected and processed for analysis. pH and EC were measured in 1: 2.5 soil water ratio (w/v) suspension using pH meter and EC meter respectively. Soil organic carbon (OC) content was estimated by Walkley and Black (1934) method.

The available nitrogen was estimated by the alkaline potassium permanganate method as described by Subbiah and Asija (1956). The available phosphorus content of soil was extracted by using Olsen's extractant as described by Olsen *et al.* (1954). The available potassium in the soils was extracted by employing neutral normal ammonium acetate and determined by aspirating the extract into the flame photometer, Systronics flame photometer 128 (Jackson, 1973). The exchangeable calcium and magnesium were determined by Versenate method.

[1]RVS Agricultural College, Thanjavur-613 402, Tamil Nadu, India. [2]Department of Soil Science and Agricultural Chemistry, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal-609 603, Puducherry, UT, India.

Corresponding Author: S. Selvaraj, Department of Soil Science and Agricultural Chemistry, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal-609 603, Puducherry, UT, India. Email: selvaraj147@gmail.com

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The concentration of exchangeable cations Ca^{2+} and Mg^{2+} were expressed in mg kg^{-1} soil (Chopra and Kanwar, 1991). Available sulphur was determined by spectrophotometrically as described by Chesnin and Yien, (1951).

The water samples were collected in capped high density PVC bottles, fortified with one mL toluene to arrest any biological activity. The samples were analyzed for EC, pH, CO_3^{-2}, HCO_3^{-}, TSS, Cl^{-}, Ca^{2+}, Mg^{2+}, K and Na^{+} by following the procedures outlined in USDA Handbook No. 60 (Piper, 2002). Water samples were also categorized on the basis of criteria adopted by All India Coordinated Research Project (ACRIP) on Management of Salt Affected Soils and Use of Saline Water in Agriculture through the values of EC, SAR and RSC of the samples (Gupta *et al*., 1994).

RESULTS AND DISCUSSION

The present study in ten villages of soil and water samples collected in Palayapatti and surrounding villages in Thanjavur district. In soil samples important chemical properties and water quality parameters assessed reported in Table 1 and Table 2.

Chemical properties

Soils of villages studied were slightly acidic to slightly alkaline. The pH values ranged from 6.18 (South Palayapatti) to 7.50 (Sithambarapatti village). Soil pH values of the studied profiles irrespective of soil depth varied from 4.4 to 7.1 showing strongly acidic to neutral reaction of the soils studied (Upadhayaya *et al.,* 2013).

The electrical conductivity of soil varied from 0.51 to 0.85 dSm^{-1}. The EC of the soil water suspension showed lowest value in Thakannur village and highest valued in Karupupatti village. Sachin *et al* (2021) explained about the electrical conductivity of the soils ranged from 0.10 to 1.10 dSm-1 Chikkamagalur district of Karnataka. The organic carbon content in different villages ranged from 0.10 to 0.27%. The highest value observed in Thakkanur village and lowest value observed in Aachampatti village. The same type result obtained by Arivoli *et al.* (2021) said that SOC value ranged between 0.09 to 1.5% in Ranipet district of Tamil Nadu.

Primary and secondary nutrient analysis

The soil available nitrogen ranged from 40.3 kg ha^{-1} in Chidambarapatti to 49.8 kg ha^{-1} in Thakannur village. Samal *et al*. (2010) reported that the content of available nitrogen 272 kg/ha, P_2O_5 (28.75 to 51.75 kg/ha) and K_2O content (135 to 335 kg/ha).

The available phosphorus in soil varied from 2.48 to 5.51 kg ha^{-1}. The highest available phosphorus observed in Kathadipatti village and lowest value of phosphorus in South Palayapatti village. The same type report observed by Trivedi *et al.* (2010) that the overall P content in the soils of western plain of Rajasthan varied from 173.61-313.94 mg kg^{-1} with mean value 223.88 mg kg^{-1}.

The available potassium in farm soil ranged between 43.5 and 68.3 kg ha^{-1}. The lowest value observed in Solagampatti soil and highest value observed in Kathadipatti soil. Dhanorkar *et al.* (2013) explained that the soils with low potassium were distributed in Sadashivpet, Zaheerabad, Sangareddy, Narayankher, Dubbak, Siddipet, Narsapur, Ramayampet divisions and of medium potassium were found in Gajwel, Medak, Siddipet, Narayankher, Ramayampet, Dubbak.

The available calcium varied in the range between 17.4 mg kg^{-1} and 32.1 mg kg^{-1}. The highest calcium content in Chidambarapatti and lowest value observed in Sellapanpatti village field soil. The same type of result observed in Chandan river system of Banka and Bhagalpur district of south Bihar that the soils of lower and medium were rich in bases (Ca^{2+} and Mg^{2+}) whereas soils of upper pedons were comparatively poor in bases Panday and Kumar (2014).

The available magnesium content exhibited in the farm blocks ranged in different aspect. The lowest value observed in Aachampatti soil as 8.1 mg kg^{-1}. And highest value observed as 12.8 mg kg^{-1} in Karupupatti. These soils have wider exchangeable Ca to Mg ratio indicating the dominance of calcium bearing minerals (Baruah *et al.* 2011).

The available sulphur ranged between 11.3 mg kg^{-1} and 19.5 mg kg^{-1}. The highest value observed in Sellappanpatti and lowest value gathered in Karupupatti village. The available sulphur in Vertisols, Inceptisols and Entisols were ranged from 1.50 to 51.25, 1.25 to 57.75 and 1.75 to 49.00

Table 1: Chemical properties in soil.

Sample collected villages	pH	EC (dSm^{-1})	OC (%)	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}	Ca ($mgkg^{-1}$)	Mg (mg kg^{-1})	S (mg kg^{-1})
Aachampatti	6.24	0.72	0.10	40.4	3.15	60.2	25.4	8.1	14.3
Kathadipatti	7.21	0.81	0.15	42.5	5.51	68.3	18.4	10.3	12.5
Chidambarapatti	7.50	0.80	0.11	40.3	5.15	47.8	32.1	9.3	11.5
North Palayapatti	7.29	0.73	0.18	42.5	3.50	60.3	28.1	12.3	17.5
South Palayapatti	6.18	0.54	0.19	42.5	2.48	66.8	25.3	9.8	18.6
Sellappanpatti	7.31	0.64	0.18	42.4	2.82	55.0	17.4	10.8	19.5
Avarampatti	7.01	0.69	0.20	45.4	3.48	63.0	17.6	11.5	17.1
Thakannur	7.31	0.51	0.27	49.8	4.82	53.5	18.9	11.3	18.2
Solagampatti	7.25	0.80	0.25	43.4	4.82	43.5	19.2	10.5	15.3
Karupupatti	7.32	0.85	0.22	45.6	5.15	50.1	20.3	12.8	11.3

Table 2: Water quality parameters.

Sample collected villages	pH	EC (dSm^{-1})	CO_{3-} (meq/ L)	HCO_3^{2-} (meq/ L)	Ca (meq/ L)	Mg (meq/ L)	TSS (ppm)	Cl^- (meq/L)	Na (meq/L)	K (meq/L)	RSC (meq/L)	SAR
Aachampatti	7.5	1.5	27.45	43.21	11.5	34.7	153	2.3	23.4	22.4	1.22	8.90
Kathadipatti	7.2	0.8	23.10	35.23	19.4	26.6	254	5.2	32.1	12.9	2.10	9.07
Chidambarapatti	7.1	1.1	19.45	17.34	18.5	42.5	198	6.7	45.2	16.3	3.25	10.23
North Palayapatti	7.0	0.8	18.31	19.31	10.8	28.4	134	5.5	54.5	17.8	4.28	8.21
South Palayapatti	6.9	1.1	23.87	16.23	7.2	42.1	231	4.7	34.1	23.6	3.90	11.23
Sellappanpatti	6.5	0.9	28.31	23.50	5.5	22.2	202	8.9	23.5	26.3	2.90	10.45
Avarampatti	7.0	1.3	27.21	17.32	5.1	26.4	265	7.1	39.5	24.1	1.78	12.89
Thakannur	7.4	1.4	18.34	20.23	7.4	30.2	214	6.3	40.1	27.2	2.43	14.23
Solagampatti	8.0	1.2	12.90	29.12	5.4	24.8	610	5.8	46.3	25.4	2.56	16.23
Karupupatti	7.3	0.7	29.24	30.12	8.2	16.2	213	7.2	45.6	19.4	5.65	12.35

mg kg^{-1} with a mean value 9.96, 11.00 and 10.34 mg kg^{-1}, respectively. Among Entisols recorded 14 per cent samples in medium category and remaining 86 per cent in low category (Cheke *et al.,* 2015).

Water quality parameters

The pH value varied in water sample between 6.5 and 8.0. The lowest pH value observed in water sample of Sellappanpatti villlage and highest value observed in Solagampatti village. According to Kaledhonkar *et al*. (2012) reported that the average pH (1:2) was 8.0 (7.2-9.0) during *rabi* of 2004-05 while it was observed as 8.26 (7.74-8.72) during 2006-07 in sub-surface drainage in Haryana.

The EC value was in the range between 0.7 and 1.5 dSm^{-1}. The highest EC observed in Aachampatti water sample and lowest EC depicted in Karupupatti water samples. In Kanina block, electrical conductivity (EC) ranged from 0.35 to 9.29 dS m^{-1} with a mean of 2.37 dS m^{-1}. Shahid *et al.* (2008) also reported similar results in Julana block of Jind district.

The carbonates values varied between 12.90 meq/l and 29.24 meq/l. The highest value observed in Karuppupatti water sample and Solagampatti water having lowest carbonate content. The salt composition showed dominance of CO_3^{2-} (1.5 to 3.0 me L^{-1}) and HCO_3^- (2.5 to 13.2 me L^{-1}) also present (Mandal, 2012). The bicarbonate content depicted as lowest value (17.32 meq/l) and highest value (43.21 meq/l). The lowest value observed in Avarampatti field and highest value observed in Aachampatti water samples. The similar result observed that in anions dominance of bicarbonate ranges from 0.40 to 24.22 m.e. L^{-1} bicarbonate followed by 0.05 to 12.04 m.e.L^{-1} chloride (Singh and Dubey, 2014).

The calcium content varied between 5.1 meq/l and 19.4 meq/l. The highest value observed in Kathadipatti field water and lowest value observed in Aavarampatti field water. The same observed by Arora et al. 2012 that Irrigation with NTW resulted in significant decrease in divalent cations (Ca^{2++} and Mg^{2+}) content specifically for saline soil; all level of Ca^{2++} Mg^{2+} content was unaffected for normal and alkali soil when compared with initial soil. The magnesium content ranged from 16.2 meq/l to 42.50 meq/l. The highest value observed in Chidabarapatti field water and lowest value observed in Karupupatti field water.

The chloride content varied between 2.3 meq/l and 8.9 meq/l. The highest value observed in Sellappanpatti field water and lowest value observed in Aachampatti field water. Arora *et al.,* 2012 explained that these quality waters were synthesized freshly every time using bicarbonate, chloride and sulphate of calcium, magnesium and sodium in the syntax water tanks in Karnal.

The sodium content ranged from 23.4 meq/l in Aachampatti field and 54.5 in North Palayapatti field water. Dominating cations in these waters of this PS area were sodium which ranged from 0.16 to 59.69 m.e. L^{-1} followed by calcium from 0.20 to 16.22 m.e. L^{-1} (Singh and Dubey, 2012).

The potassium content ranged between 12.9 meq/l and 27.2 meq/l. The highest potassium content observed in Thakannur field water and lowest potassium content observed in Kathadipatti field water. In case of cations, sodium was the dominant ion which ranged from 2.90 to 60.20 me L^{-1} followed by magnesium (0.45 to 19.50 me L^{-1}), calcium (0.15 to 6.10 me L^{-1}) and potassium (0.10 to 2.10 me L^{-1}) in Haryana by Ramprakash *et al.,* 2013.

Water quality

The sodium hazard value observed more in 16.97 (tamarind field water) and lowest value (8.21) observed in North Palayapatti field water. The similar results showed by Shahid *et al.* (2008) that the lowest SAR value was observed in village Bamanwas and the highest value was observed in village Desh Khera, Haryana. The magnitude of Na+ in soil is quantified by the exchangeable sodium percentage or by its estimator, the sodium adsorption ratio SAR (Muneer *et al.,* 2012).

The RSC value ranged between 1.22 meq/l and 5.65 meq/l. The highest RSC content observed in Karupupatti field water and lowest in Aachampatti field water. High RSC water is characterized by low total salts concentration. The relative proportion of calcium and magnesium is much smaller as compared to sodium. Such waters have carbonates and bicarbonates predominant anions (Sharma *et al.,* 2014).

CONCLUSION

Soils were slightly acidic to slightly alkaline, normal EC and low organic carbon, low to medium content of nitrogen, phosphorus and potassium, low to medium content of calcium, magnesium and sulphur. Water samples were slightly acidic to moderately alkaline pH, medium to high salt content, moderate amount of carbonate and bicarbonate content, low to medium content of TSS, normal to problematic Ca and Mg, Normal Na and K, Low to medium of SAR and good to fair RSC. Good quality and marginally saline waters can be successfully used for crop production without any hazardous effect on soil and plants. But in contingency, these waters can be used with special management practices depending upon the rainfall, crop to be grown and soil type.

Conflict of interest

We wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

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