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Characterization of Sodic Soils of North Western Zone of Tamil Nadu

M. Jayakumar*, V. Balasubramanian and T.S. Manickam
Department of Agronomy, Faculty of Agriculture,
Annamalai University, Chidambaram, Tamil Nadu, South India

An attempt has been made on characterization of sodic soils by using reconnaissance soil survey methods in North Western Zone of Tamil Nadu encompassing the districts of Dharmapuri, Salem, Krishnagiri and Namakkal during January 2009 to August 2009. Surface soil samples were collected as per reconnaissance soil survey reports of Dept. of Agriculture and analyzed the soil pH and EC. Based on the analytical report the severity of sodicity problem was quantified. Then profiles were dug and detailed analyses were taken up in the sodic soil inflicted areas. Considerable area of sodic soils to the extent of 26,279 ha was identified under the soil series *viz.,* Peelamedu, Salem, Mallur, Thulukkanur, Mallasamudram, Upparapatti, Periyanaickanpalayam, Nattam, Dharmapuri, Krishnagiri and Harur. Among the soil series detailed analysis of profile samples like pH, EC, ESP and SAR the Mallasamudram soil series was identified as most affected by sodicity. The pH range of the above series was 9.1 to 10.0, EC of 0.8 to 1.2 dsm^{-1} and ESP of 32 and 48 per cent was predominantly noticed compared to other soil series. The land capability and productivity classes were poor in the above soil series.

Key words: Soil characterization, North Western Zone, sodicity, land capability class (LCC).

The present population of the country is 1110 million and the annual food grain production has been to a tune of 205 million tonnes. India's population is expected to cross 1400 million by 2025 A.D. With this scenario in mind, on an average, the country has to raise the annual food production by 5 million tonnes from the existing 205 million tonnes to reach the food grain requirement 261.5 to 267.0 million tons by 2020-2021 (Chand, 2007). In order to cope with the food grain requirements of the increasing population, the agricultural production has to be stepped up substantially. This can be done either by multiple cropping on the existing cultivated lands or by bringing the additional land area under cultivation. The possibility to increase the food grain production to the required extent by these two ways is very much limited in India. The only feasible alternative is to increase the cultivated land area by bringing the wastelands and problem soils under cultivation.

The problems of soil sodicity, salinity and of poor quality water are likely to increase in the near future due to planned expansion in irrigated area and intensive use of natural resources to meet food, fodder, fibre and timber requirement of the burgeoning human and livestock populations. Tentative estimate indicates that the salt affected soils will constitute nearly 13 m ha area in the country by 2025. Out of this, Tamil Nadu State alone has 0.43 million ha of salt affected soils. The reclamation and utilization of thirteen million hectare of salt affected soils can lead to an additional production of 50 - 60 million tonnes of food grain every year. As a result of the technologies generated by the CSSRI, Karnal over the years, more than 1.3 million ha salt affected soils have been reclaimed. The reclaimed area is contributing more than 8 million tonnes additional food grains (Anon., 2007).

The study area encompasses the districts of Dharmapuri, Krishnagiri, Salem and Namakkal which comes under the North Western Agro Climatic Zone of Tamil Nadu. The Agro Climatic Zone is the ideal and common working unit of all agricultural developmental activities; considerable area of sodicity in this zone hampered the agricultural production. The reclamation of these area leads to increased productivity and hence, the present study was under taken covering a specific zone.

Materials and Methods

Soil characterization

Soil Survey and Land Use Organization of the State Department of Agriculture, Government of Tamil Nadu generated soil maps for the study area, comprising the districts of Salem, Namakkal, Dharmapuri and Krishnagiri. They were utilized as the basic data in the present study. Further a detailed reconnaissance soil study was carried out in the villages where soils are affected by sodicity as per procedures outlined in the USDA Soil Survey Manual

*Corresponding author email: agrokumar@yahoo.com

(1999) using village cadastral maps. Taking into consideration of the nature of soil series, intensive field surface samplings (0-15 cm) were taken up in sodic soil affected villages. Sampling intensity was based on the rate of soil inflicted with sodicity. These surface soils were analyzed for its pH, EC (potentiometry- Jackson, 1973), and identified village wise sodicity inflicted area. For the characterization of soils, systematic field traverse were made, profiles examined and horizon wise samples were collected (USDA, 1999). Based on the analytical results, taluk wise salt inflicted area have been identified and tabulated.

Results and Discussion

Based on the surface soil samples analytical results, taluk wise salt inflicted areas have been identified and tabulated (Table. 1). The area of

Table 1. Details of district wise and soil series wise pH range in sodic soil areas

District	Taluk	Total no. of samples analyzed	pH range (No. of samples)				Area affected by sodicity (ha)
			< 8.5	8.6 – 9.0	9.1– 9.5	9.6-10	
Salem	Salem	161	49	91	19	2	1217
	Vazhapadi	128	35	90	3	-	889
	Sankari	1083	43	420	368	252	3498
	Omalur	125	18	83	20	4	500
	Mettur	25	17	8	-	-	200
	Attur	260	81	174	5	-	2731
Namakkal	Tiruchengode	568	68	264	154	82	3802
	Rasipuram	115	55	58	2		765
	Paramathi	84	30	50	4	-	1070
	Namakkal	223	56	158	9	-	2567
Dharmapuri	Dharmapuri	113	46	66	1	-	1381
	Harur	70	25	41	4	-	758
	Papireddipatti	85	46	39	-	-	945
	Palacode	95	31	64	-	-	1049
	Pennagaram	35	22	13	-	-	240
Krishnagiri	Krishnagiri	243	61	160	15	7	3703
	Utangarai	80	30	49	1	-	964
Total	-	3493	713	1828	605	347	26279

occurrence of soil series in taluk wise is presented in Table 2. The soil series Peelamedu, Salem, Mallur, Tulukkanur, Mallasamudram, Upparapatti, Periyanaickanpalayam, Nattam, Dharmapuri, Krishnagiri and Harur series are found to be inflicted with the problem of sodicity in patches excepting Mallasamudram series. The results of profile soil sample analysis are given in Table 4. The soil analytical results revealed that the samples collected from Tiruchengode and Sankari taluks, which are adjacent to each other, recorded higher pH range compared to others taluks. Next to this, Krishnagiri taluk recorded higher number of samples under the pH range of 9-10. The occurrence of Mallasamudram soil series both in Sankari taluk of Salem district and Tiruchengode taluk of Namakkal district extends to an area of 4228 ha. Analytical results of surface soil samples revealed that, the above soil series are highly sodic and contiguous.

Problem soils of ayacut areas

North Western Zone has dams constructed for irrigation purposes in Krishnagiri district. Krishnagiri Reservoir Project (KRP) irrigates around 3600 ha. The irrigated areas are nearly level in topography and the distributory system of unlined canals leading to seepage and water logging. It is estimated that 2000 ha of KRP dam ayacut area was affected by varying magnitude of sodicity. The problem soil series like Nattam, Krishnagiri and Thimmapuram revealed that the surface soil texture was found to be clay loam and is heavy in nature due to which the drainage is the problem. In Salem district the total ayacut area of Mettur dam is 6050 ha out of which 966 ha of Tulukkanur, Upparapatti soil series were found to be affected by sodicity. With regard to Namakkal district, out of total Mettur dam ayacut area of 4528 ha, an area of 882 ha in Pallipalayam and Upparapatti soil series were found to be affected by varying degree of sodicity. The problem of soil sodicity is due to inadequate drainage and unlined canals.

Problem soils of non-ayacut area

In North Western Zone of Tamil Nadu, Tiruchengode taluk of Namakkal district was most affected by sodicity with an area of 3802 ha; the major soil series affected being Mallasamudram and Sankari taluk of Salem district being affected by sodicity with an area of 3498 ha, the major soil series affected being Mallasamudram. Among the soil series studied Mallasamudram soil series is found to be more sodic with a pH range of 9.0 to 10.0. Among different soil series profile, detailed analysis

Table 2. Details of taluk wise and soil series wise sodic soil area (in ha)

District	Taluk	Sodic soil occurring soil series							
		Plm	Slm	Mal	Tlk	Msm	Upi	Pyk	Total
Salem	Salem	232	544	388	30	23	-	-	1217
	Vazhapadi	35	551	303	-	-	-	-	889
	Sankari	-	-	-	836	2212	450	-	3498
	Omalur	500	-	-	-	-	-	-	600
	Mettur	200	-	-	-	-	-	-	170
	Attur	-	-	-	-	-	-	2731	2731
Total		967	1095	691	866	2235	450	2731	9035
		Plm	Upi	Ppm	Tlk	Msm			
Namakkal	Tiruchengode	-	-	1061	748	1993			3802
	Rasipuram	765	-	-	-	-			765
	Paramathi	-	955	-	115	-			1070
	Namakkal	-	714	1853	-	-			2567
Total		765	1669	2914	863	1993			8204
		Ntm	Dpi	Top	Kgr	Hrr			
Dharmapuri	Dharmapuri	100	1176	105	-	-			1381
	Harur	-	-	-	-	758			758
	Papireddipatti	-	212	95	-	638			945
	Palacode	317	237	307	188				1049
	Pennagaram		85	155					240
Total		417	1710	662	188	1396	-	-	4373
Krishnagiri	Krishnagiri	-	-	-	3703	-	-	-	3703
	Uthangarai	-	-	30	70	864	-	-	964
Total		-	-	30	3773	864	-	-	4667
Grand total									26279

showed that profile samples of Mallasamudram soil series recorded higher pH and ESP. The texture of the above soil series is also clay loam in nature. Similar findings were reported by Venkatesan and Thiyagarajan (1998) and Anon (2001). The available nutrient status of these soils indicated that N was low, P and K are low to medium respectively. In general, salt affected soils are low in N status owing to poor organic matter content, slower rate of its transformation and mineralization and increased

Table 3. Details of profile soil sample analytical result

Series	Depth	Texture	pH	EC	CEC	Ex Ca	Ex Mg	Ex K	Ex Na	SAR	ESP
Krishnagiri	0-18	Cl	9.0	0.4	20.2	7.8	4.1	0.19	6.8	2.78	33.6
	18-30	Sc	9.0	0.4	15.5	9.9	3.1	0.10	4.9	1.96	31.6
	30-60	Sc	9.0	0.6	24.5	10.1	3.7	0.10	10.1	3.85	41.2
	60-75	C	9.1	0.6	28.4	7.6	5.7	0.10	10.7	4.26	38.0
	75-105	C	9.2	1.0	27.3	8.3	7.2	0.16	11.2	4.02	41.9
Harur	0-16	Scl	8.9	1.2	17.2	8.2	3.8	0.30	5.2	2.13	30.2
	16-34	Sc	9.0	0.8	16.4	7.4	4.2	0.40	4.2	1.75	25.6
	34-57	Scl	9.0	0.8	19.2	11.2	3.5	0.30	3.8	1.40	19.8
	57-81	Scl	9.1	0.9	20.2	9.2	2.8	0.10	6.0	2.45	29.7
	81-115	Sc	9.1	1.0	18.6	8.6	3.6	0.20	4.9	1.99	26.3
Nattam	0-17	Cl	9.0	0.8	19.9	9.05	6.5	0.16	4.2	1.50	21.1
	17-31	Sl	9.0	0.6	18.6	10.6	2.6	0.06	4.4	3.12	27.3
	31-51	Sc	9.1	1.1	24.1	11.4	1.8	0.10	9.6	3.73	39.8
	51-95	Sc	9.1	1.2	19.4	8.10	2.2	0.10	8.6	3.78	44.3
	95-130	Scl	9.0	1.2	16.8	7.25	1.2	0.20	6.3	3.40	35.1
Uppara-patti	0-15	Scl	8.2	0.6	18.2	9.8	2.5	0.4	4.2	2.07	23.0
	15-60	Cl	8.3	0.8	17.8	10.2	1.4	0.6	3.6	2.27	20.2
	60-98	Scl	8.2	1.2	19.2	9.6	2.6	0.5	5.1	2.06	26.5
Malla-samudram	0-20	Scl	9.5	0.8	24.2	9.8	3.5	0.8	9.2	3.78	32.4
	20-65	Scl	9.7	1.2	20.4	7.4	3.2	1.2	8.4	3.64	38.0
	65-81	Sc	9.5	1.0	24.6	6.5	4.8	1.0	10.8	4.54	44.0
	81-115	C	9.6	1.1	30.4	8.2	6.4	1.4	14.2	5.29	46.7
Periya-naickan-palayam	0-16	Sc	8.9	0.2	17.2	7.6	4.4	0.8	3.4	1.38	19.7
	16-47	C	9.0	0.9	19.6	8.3	6.6	0.3	4.0	1.47	20.4
	47-81	C	9.1	0.8	18.6	7.2	4.6	0.2	4.8	1.18	25.8
	81-127	Scl	9.0	0.7	17.9	8.1	3.2	0.3	5.2	2.18	29.0

rate of NH_3 volatilization under high sodic conditions. This is in agreement with the findings of Malival and Timbadia, (1993). Available micronutrient status of the study area soils indicated that Zn was deficient in both the locations. High pH, low organic matter content and high $CaCO_3$ strongly limit the micronutrient availability particularly Zn and Cu to the crops. Similar findings were reported by Singaravel (1997).

Table 4. LCC of different problem soil series

Soil Series	L.C.C	Limitations
Pallipalayam	IIs	Sodicity
Peelamedu	IIIs	Sodicity, runoff, cracks
Periyanaickanpalayam	IIIs	Sodicity, runoff, cracks
Mallasamudram	IIIs	Sodicity
Mallur	IIe	Erosion, sodicity
Nattam	IIIsw	Sodicity, poor drainage, heavy texture
Krishnagiri	IIIws	Sodicity, poor drainage, heavy texture
Dharmapuri	IIIs	Heavy texture, sodicity
Harur	IIes	Erosion, runoff, heavy texture, sodicity

Profile analysis

In general, the profile depth of problem soils like Mallasamudram, Upparapatti, Periyanaickanpalayam, Nattam, Krishnagiri and Harur are deep in soil depth. The texture varied from clay loam to clay. It showed that the problem soils are heavy textured and the permeability is very slow.

The results of profile analysis confirm that the higher pH leads to sodicity. The CEC value also correlated with heavy texture. The values of exchangeable Na and ESP confirm the sodicity in soils. Due to poor drainage, sodicity and heavy texture the problem soils come under LCC class of II and III (Tables 3 and 4).

Conclusion

North Western Agro Climatic Zone of Tamil Nadu is the ideal and common working unit of all agricultural developmental activities; considerable area of 26,279 ha was identified under the soil series *viz.,* Peelamedu, Salem, Mallur, Thulukkanur, Mallasamudram, Upparapatti, Periyanaickan palayam, Nattam, Dharmapuri, Krishnagiri and Harur. Among the soil series Mallasamudram series was identified as most affected by sodicity. The reclamation of these soils leads to increased agricultural production, managing the soil fertility and conserving the environment.

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