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ASSESSMENT OF NUTRIENT STATUS OF RICE GROWING SOILS OF CANAL AYACUT SOILS OF KURNOOL DISTRICT (A.P.), INDIA

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Abstract

The nutrient status of eleven (11) mandals of rice growing soils of canal ayacut of Kurnool district of Andhra Pradesh was evaluated for pH, EC, OC, texture, CEC, available N, P, K status, exchangeable cations and different forms of potassium such as water soluble K, available K, exchangeable K, non-exchangeable K and fixed K. The texture of the studied soils belongs to moderately coarse to fine texture with a mean pH value of 7.83 and EC ranging from 0.06 to 1.71 dS m^{-1}. The CEC ranged from 14.43 to 31.65 C mol (p^+) kg^{-1}. The organic carbon content was in the range of 0.32 to 0.87%. The soils were low to medium in available N with range being 188 to 327 kg ha^{-1}, medium to high in available P which a range of 67 to 226 kg P_2O_5 ha^{-1} and medium to high in available K with a range of 158 to 2343 kg K_2O ha^{-1}. The exchangeable cations were in the order of $Ca^{+2} > Mg^{+2} > Na^+ > K^+$. The order of dominance of different forms of potassium was Fixed K > non exchangeable K > available K > exchangeable K > water soluble K and different forms of potassium had positive correlation among themselves indicating dynamic equilibrium between them.

Key words : Potassium forms, CEC, OC, clay, exchangeable cations and texture.

Introduction

Rice is one of the most important staple foods for more than half of the world's populations. Potassium (K) is very instrumental in plant nutrition and Physiology, K has been found to activate over sixty enzymes. It also promotes photosynthesis, controls stomata opening, improves the utilization of N, promotes the transport of assimilates and consequently increases crop yields. In the past, research on potassium has lag behind those of the other major nutrients because of the general impression that most of the Indian soils are well supplied with this element. However, after introduction of high yielding varieties and increasing use of nitrogen and phosphorus in the last two decades, crop responses to potassium have become wide spread. The soils of Kurnool district are put to intensive cultivation with rice crop in canal ayacut to meet the urban demand. Hence, an investigation has been planned on rice growing soils of Kurnool district to study the different soil properties, K status and evaluate the different forms of potassium in the soil for supplementing the crop with proper amounts of fertilizer K.

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Materials and Methods

Soil collection and preparation

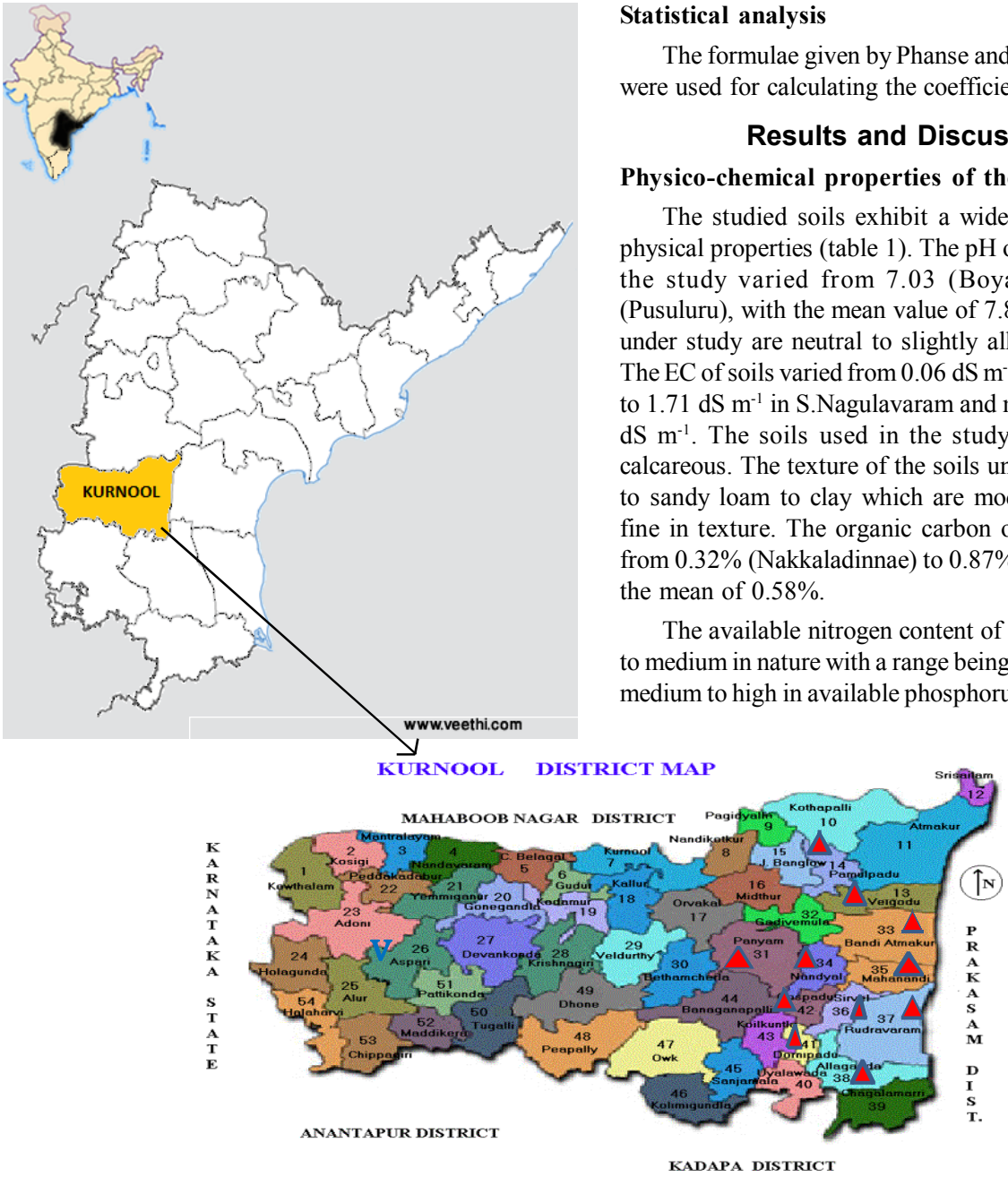
Thirty surface soil samples are collected from eleven mandals of rice growing soils of Kurnool district for the study. The studied area lies between the geo-coordinates of N 15^0 08' to 15^0.47' and E 078^0 20' to 078^0 38'. The soils samples collected locations are shown in the fig. 1. The soil samples collected were air dried, ground with wooden hammer and passed through 2 mm sieve and preserved in a polyethene bag, for laboratory analysis.

Soil analysis

The samples were analyzed for particle size analysis by Bouyoucous hydrometer method and chemical properties *viz*., pH, EC, organic carbon, $CaCO_3$, Cation Exchange Capacity, exchangeable cations, available Nitrogen, phosphorous and potassium were determined as per standard procedures outlined by Jackson (1973).

Potassium forms in soils

Water soluble potassium was determined in 1:5 soil : water extract, after 5 minutes shaking (Kanwar and Grewal, 1966). The available potassium was determined by NN NH_4OAc (pH 7.0) extract method with 1:5 soil :



Mandals: (▲)
Velugodu -13, Pamulapadu -14, Bandi Atmakur- 33, Mahanandi -35, Nandyal- 34, Panyam -31, Gospadu -42, Sirvel -36, Rudravaram -37 , Dornipadu -41, Allagada -38

Fig. 1 : Map showing Canal Ayacut Mandals in Kurnool district.

extract, after 5 minutes shaking as described by Jackson (1973). The exchangeable potassium was obtained as a difference of the available and water soluble potassium. The fixed form of potassium was determined by boiling for 10 min with 1 N HNO_3 (1:10 soil : acid ratio). The Non-exchangeable potassium was obtained by deducting the available potassium from fixed potassium contents (Wood and Deturk, 1941).

Statistical analysis

The formulae given by Phanse and Sukhatme (1978) were used for calculating the coefficients of correlation.

Results and Discussion

Physico-chemical properties of the soils

The studied soils exhibit a wide range of general physical properties (table 1). The pH of the soils used in the study varied from 7.03 (Boyarevula) to 8.51 (Pusuluru), with the mean value of 7.83. Thus, the soils under study are neutral to slightly alkaline in reaction. The EC of soils varied from 0.06 dS m^{-1} in Nakkaladinnae to 1.71 dS m^{-1} in S.Nagulavaram and mean value is 0.42 dS m^{-1}. The soils used in the study belongs to non-calcareous. The texture of the soils under study belongs to sandy loam to clay which are moderately coarse to fine in texture. The organic carbon of the soils varied from 0.32% (Nakkaladinnae) to 0.87% (Parnapalli) with the mean of 0.58%.

The available nitrogen content of the soils were low to medium in nature with a range being 188 to 327 kg ha^{-1}, medium to high in available phosphorus which a range of 67 to 226 kg P_2O_5 ha^{-1} and medium to high in available potassium with a range of 158 to 2343 kg K_2O ha^{-1}. The Cation Exchange Capacity of the soils varied between 14.43 to 31.65 C mol (p^+) kg^{-1} soil.

The exchangeable cations data of the investigated soils are presented in table 2. The sodium content of the soils varied from 0.75 to 5.42 C mol (p^+) kg^{-1} soil with the mean value of 2.20 C mol (p^+) kg^{-1}. The sodium content

Table 1 : Salient properties of different investigated soils of Kurnool district.

S. no.	Village name	Mandal	pH	EC (dS m^{-1})	$CaCO_3$ (%)	OC (%)	Available N	Available P_2O_5	Available K_2O	Clay	Silt	Sand	Texture
							(kg ha^{-1})			%			
1	Ramchandrapuram	Dornipadu	8.14	0.25	4.20	0.59	307	177	289	43.08	8.36	48.56	Sandy clay
2	Poluru	Nandyala	7.61	1.37	4.40	0.47	279	144	771	41.00	10.36	48.64	Sandy clay
3	S.Nagulavaram	Gospadu	7.85	1.71	4.70	0.39	251	67	298	41.08	20.36	38.56	Clay loam
4	Panyam Rural	Panyam	7.53	1.35	4.30	0.45	280	199	461	39.08	10.36	50.56	Sandy clay
5	Jutur	Pampulapadu	7.75	0.24	4.20	0.61	298	179	592	31.08	0.36	68.56	Sandy clay loam
6	Allagadda Rural	Allaggada	8.17	0.27	3.60	0.57	285	177	610	41.08	12.36	46.56	Sandy clay
7	Pusuluru	Nandyala	8.51	0.19	3.80	0.33	232	74	668	43.08	16.36	40.56	Clay
8	Nallagatla	Allagada	7.87	0.70	3.10	0.66	287	205	718	39.08	16.36	44.56	Sandy clay
9	Ammireddy Nagar	Dornipadu	8.20	0.24	3.20	0.75	299	215	751	33.08	12.36	54.56	Sandy clay loam
10	RARS, Nandyala	Nandyala	7.62	0.49	3.10	0.59	307	133	783	43.08	14.36	42.56	Clay
11	Gorukallu	Panyam	8.11	0.22	2.70	0.50	201	212	879	35.08	6.36	58.56	Sandy clay
12	Bollavaram	Mahanandhi	7.79	0.30	3.20	0.76	294	154	959	31.08	12.36	56.56	Sandy clay loam
13	Thamadapalli	Mahanandhi	7.71	0.21	2.90	0.63	287	200	1386	39.08	12.36	48.56	Sandy clay
14	Velpanuru	Velugodu	8.04	0.39	3.60	0.82	286	79	1087	35.08	2.36	62.56	Sandy clay
15	Nakkaladinnae	Rudravaram	7.74	0.06	2.60	0.32	188	111	158	15.08	0.36	84.56	Sandy loam
16	Bachapuram	Rudravaram	7.80	0.17	3.20	0.52	281	128	243	31.08	10.36	58.56	Sandy clay loam
17	Boyarevula	Velugodu	7.03	0.18	3.50	0.37	259	121	293	19.00	14.36	66.64	Sandy loam
18	Yerraguntla	Srivella	8.08	0.26	2.70	0.83	314	163	538	34.08	11.36	54.56	Sandy clay loam
19	Parnapalli	Bandi Atmakur	7.37	0.86	3.80	0.87	327	207	486	29.08	12.36	58.56	Sandy clay loam
20	Padakandla	Allagada	7.52	0.28	1.70	0.55	281	117	548	33.08	15.36	51.56	Sandy clay loam
21	Ayyaluru	Nandyala	7.24	0.35	3.60	0.37	217	126	778	29.08	10.36	60.56	Sandy clay loam
22	Kanala	Nandyala	7.91	0.14	3.80	0.48	245	113	703	25.08	14.36	60.56	Sandy clay loam
23	M.C.Farm, College	Mahanandhi	7.72	0.22	2.70	0.59	263	174	1205	19.00	12.36	68.64	Sandy loam
24	Rayapadu	Gospadu	8.01	0.23	2.80	0.76	283	216	1146	29.08	16.36	54.56	Sandy clay loam
25	Munagala	Nandyala	8.33	0.47	3.20	0.60	286	204	2343	29.08	18.36	52.56	Sandy clay loam
26	Mandaluru	Rudravaram	7.39	0.20	2.60	0.54	278	185	652	33.08	16.36	50.56	Sandy clay loam
27	Gajulapalli	Mahanandhi	7.57	0.10	3.10	0.41	246	149	820	29.08	8.36	62.56	Sandy clay loam
28	Chennuru	Srivella	8.15	0.55	3.20	0.33	213	144	351	31.08	10.36	58.56	Sandy clay loam
29	Thellapuri	Gospadu	8.20	0.34	2.70	0.57	282	185	1053	39.08	16.36	44.56	Sandy clay
30	Ayyavari Koduru	Bandi Atmakur	7.75	0.21	2.80	0.74	301	226	554	31.08	4.36	64.56	Sandy clay loam
Mean			**7.83**	**0.42**	**3.30**	**0.58**	**272**	**159**	**737**	**33.17**	**11.53**	**55.30**	

Table 2 : Exchangeable cations of the investigated soils.

S.No	Village name	C.E.C C mol (p^+) kg^{-1}	Exchangeable cations (C mol (p^+) kg^{-1})			
			K	Ca	Mg	Na
1	Ramchandrapuram	15.02	0.28	9.00	3.70	2.56
2	Poluru	17.85	0.74	9.80	2.50	4.31
3	S.Nagulavaram	15.72	0.28	5.20	2.80	5.42
4	Panyam Rural	14.43	0.44	7.50	4.30	4.31
5	Jutur	16.26	0.57	5.60	2.50	1.80
6	Allagadda Rural	16.39	0.58	6.20	3.20	2.55
7	Pusuluru	15.24	0.64	6.80	4.50	2.52
8	Nallagatla	16.13	0.69	6.80	4.80	2.70
9	Ammireddy Nagar	31.65	0.72	8.80	4.70	1.81
10	RARS, Nandyala	16.63	0.75	9.80	3.50	2.51
11	Gorukallu	15.48	0.84	6.70	3.10	1.32
12	Bollavaram	16.63	0.92	5.50	2.50	1.50
13	Thamadapalli	17.20	1.32	6.10	5.00	0.99
14	Velpanuru	22.17	1.04	9.40	4.00	2.22
15	Nakkaladinnae	21.09	0.15	9.00	4.30	0.75
16	Bachapuram	15.30	0.23	5.40	2.90	1.24
17	Boyarevula	22.11	0.28	10.40	5.40	1.02
18	Yerraguntla	14.78	0.51	9.20	3.70	1.53
19	Parnapalli	17.61	0.46	6.40	4.00	2.70
20	Padakandla	15.43	0.52	5.80	3.80	1.87
21	Ayyaluru	14.70	0.74	4.10	2.40	1.45
22	Kanala	15.00	0.67	7.70	2.40	2.26
23	M.C.Farm, College	17.74	1.15	5.70	2.00	0.96
24	Rayapadu	14.57	1.09	8.40	3.20	1.83
25	Munagala	19.65	2.24	8.00	4.70	4.08
26	Mandaluru	20.00	0.62	10.30	4.60	1.73
27	Gajulapalli	16.52	0.78	6.00	1.90	1.04
28	Chennuru	19.35	0.34	6.20	2.50	3.10
29	Thellapuri	17.17	1.00	9.70	4.00	2.48
30	Ayyavari Koduru	18.91	0.53	7.90	3.10	1.47
Mean		**17.56**	**0.70**	**7.40**	**3.50**	**2.20**
Range		**14.43-31.65**	**0.15-2.24**	**4.10 -10.40**	**1.90-5.40**	**0.75-5.42**

was highest in S. Nagulavaram and lowest in Nakkaladinnae. The potassium content values varied from 0.15 to 2.24 C mol (p^+) kg^{-1} with a mean value of 0.70 C mol (p^+) kg^{-1}. The potassium content was highest in Munagala and lowest in Nakkaladinnae.

The Calcium content values varied from 4.10 C mol (p^+) kg^{-1} (Ayyaluru) to 10.40 C mol (p^+) kg^{-1} (Boyarevula) with a mean value of 7.40 C mol (p^+) kg^{-1} and the magnesium content values ranges from 1.90 to 5.40 C mol (p^+) kg^{-1} with a mean value of 3.50 C mol (p^+) kg^{-1}. The highest magnesium content was recorded in Boyarevula and lowest in Gajulapalli. The exchangeable cations were in the order of $Ca^{+2} > Mg^{+2} > Na^+ > K^+$. The higher exchangeable calcium in the surface soils might be due to redistribution of calcium by tree species. Similar reports were made by Patil and Prasad (2004).

Different forms of potassium in the selected soils

The different forms of potassium *viz*; water soluble, exchangeable, available, non exchangeable and fixed potassium have been presented in the table 3.

The water soluble potassium (K_{WS}) varied from 7 mg kg^{-1} (Ramchandrapuram) to 114 mg kg^{-1} (Gajulapalli) with a mean value of 34 mg kg^{-1}. The available potassium (K_{av}) varied from 59 mg kg^{-1} (Nakkaladinnae) to 872 mg

Table 3 : Different forms of potassium in the studied soils (mg kg^{-1} soil).

S. no.	Village name	Water soluble K	Available K	Exchangeable K	Non-exchangeable K	Fixed K
1	Ramchandrapuram	7	108	100	145	253
2	Poluru	24	287	262	96	383
3	S.Nagulavaram	16	111	95	129	240
4	Panyam Rural	13	171	159	266	438
5	Jutur	131	220	89	367	588
6	Allagadda Rural	20	227	207	231	458
7	Pusuluru	22	248	226	519	768
8	Nallagatla	20	267	247	263	530
9	Ammireddy Nagar	16	280	264	628	908
10	RARS, Nandyala	12	291	280	299	590
11	Gorukallu	17	327	310	121	448
12	Bollavaram	68	357	289	301	658
13	Thamadapalli	43	516	473	334	850
14	Velpanuru	29	404	375	73	478
15	Nakkaladinnae	51	59	8	64	123
16	Bachapuram	14	90	77	147	238
17	Boyarevula	82	109	28	201	310
18	Yerraguntla	12	200	188	235	435
19	Parnapalli	15	181	166	107	288
20	Padakandla	12	204	192	114	318
21	Ayyaluru	27	289	263	468	758
22	Kanala	15	262	247	263	525
23	M.C.Farm, College	58	448	391	569	1018
24	Rayapadu	21	427	406	226	653
25	Munagala	70	872	801	493	1365
26	Mandaluru	39	243	203	350	593
27	Gajulapalli	114	305	192	163	468
28	Chennuru	13	131	118	37	168
29	Thellapuri	22	392	370	288	680
30	Ayyavari Koduru	18	206	188	121	328
Mean		**34**	**274**	**240**	**254**	**528**
Range		**7-114**	**59-872**	**8-801**	**37-569**	**123-1365**

Table 4 : Inter correlation between different forms of potassium

	Water soluble K	Available K	Exchangeable K	Non-Exchangeable K	Fixed K
Water soluble K	1.000				
Available K	0.240	1.000			
Exchangeable K	0.047	0.981**	1.000		
Non-Exchangeable K	0.208	0.480**	0.453**	1.000	
Fixed K	0.261	0.862**	0.835**	0.858**	1.000

**Significant at 0.01 per cent level.

kg^{-1} (Mungala). The mean value of available potassium (K_{av}) is 274 mg kg^{-1}.

The exchangeable potassium (K_{ex}) content varied from 8 to 801 mg kg^{-1} with a mean value of 240 mg kg^{-1}. The lowest values were observed in Nakkaladinnae soils and highest in Mungala soils, where as non-exchangeable potassium ($K_{non\text{-}ex}$) ranged between 37 mg kg^{-1} (Chennuru) to 569 mg kg^{-1} (MC.Farm College) with a mean value of 254 mg kg^{-1}. The fixed potassium in the selected soils varied from 123 mg kg^{-1} (Nakkaladinnae) to 1365 mg kg^{-1} (Mungala) with a mean amount of 528 mg kg^{-1}. The order of dominance of different forms of potassium was Fixed K > Non exchangeable K > Available K > Exchangeable K > Water soluble K.

Correlation coefficients (r) among the forms of potassium

Water soluble K showed positive correlation with available K, exchangeable K, non exchangeable K and fixed K where as available K showed positive and significant correlation with exchangeable K (r = 0.981**), non exchangeable K (r = 0.480**) and fixed K (r =0.862**) (table 4). Similar results were reported by Singh *et al*. (2010). Exchangeable K showed positive and significant correlation with non-exchangeable K (r= 0.453**) and fixed K (r=0.835**). These results are in conformity with the findings of Islam *et al*. (1994) and Das *et al*. (2000). Different forms of potassium had positive correlation among themselves. This indicates the existence of dynamic equilibrium among the forms of K (Jagadish Prasad, 2010).

Non exchangeable K had positive relationship with other K fraction indicating the existence of equilibrium among the forms of K and a depletion of one form will replenishes the other forms of K (Prasad, 2010).

Conclusion

The study brings out that for the better yields there is a need of application of all the major nutrients to most of the investigated soils and the positive correlations among the different forms of potassium indicates the dynamic equilibrium among themselves and majority of potassium is found in fixed form where as water soluble potassium is lowest. Hence, the soils of the district requires judicious and frequent application of potassic fertilizers for better crop production in order to increase potassium use efficiency in the soils of canal ayacut of Kurnool district for sustainable crop productivity.

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