Andhra Pradesh J Agril. Sci : 1(3): 15-20, 2015

POTASSIUM DYNAMICS IN RELATION WITH SOIL PROPERTIES IN RICE GROWING SOILS OF KURNOOL DISTRICT, ANDHRA PRADESH

J. SWAMANNA, P. KAVITHA*, M. SREENIVASA CHARI AND M. SRINIVASA REDDY

Department of Soil Science and Agriculture Chemistry, Agriculture College, Mahanandi,

ABSTRACT

An investigation was carried out to study the different forms of potassium and their relationship with soil properties in rice growing soils of Kurnool district. The mean values of water soluble K, available K, exchangeable K, Non-exchangeable K and fixed K were of 20.42, 189.60, 169.18, 329.63 and 519.23 mg kg^{-1}, respectively. Non-exchangeable K had significant positive relationship with other K fractions indicating that equilibrium exists between different forms of potassium in the soil. The order of dominance of different forms of potassium was Fixed K > Non-exchangeable K > Available K > Exchangeable K > Water soluble K. Among the different soil properties pH, CEC, organic carbon and percentage of clay showed positive correlation with all forms of potassium, indicating that soil properties are more influence on the exist of different forms of potassium.

KEYWORDS: Available K, Exchangeable K, Non-Exchangeable K, Water soluble K, Soil properties.

INTRODUCTION

Potassium is the major nutrient and also a most abundant in soils but the K content of the soil varies from place to place based on physico-chemical properties of soil. Potassium exist in soil in different forms *viz.,* water soluble, exchangeable, non-exchangeable (fixed), mineral, lattice and total. But these forms were not homogeneously distributed in soils. Its amount in soil depends on the parent material, degree of weathering, K gains through manures and fertilizers and losses due to crop removal, erosion and leaching. Usually the amounts of non-exchangeable and total K present in the soil were high as compared to water soluble and exchangeable K. The dynamics of potassium in soil depends on the magnitude of equilibrium among various forms and mainly governed by the physico-chemical properties of soil (Lalitha and Dakshinamoorthy, 2014). The present investigation was carried out to study the different forms of potassium in relation with the soil properties in rice growing soils of Kurnool district in Andhra Pradesh.

MATERIAL AND METHODS

The surface samples collected from different locations in rice growing soils of Kurnool district were processed and analyzed for varioussoil properties such as particle size analysis by Bouyoucous hydrometer method. The pH and EC were determined in 1:2 soil: water suspension by using pH meter and EC meter, respectively. The organic carbon content, CEC and $CaCO_3$were determined as per standard procedures outlined by Jackson (1973).

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 *1N* NH_4OAC (pH 7.0) extract with 1:5 soil 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), (Wood and Turk, 1941). The Non-exchangeable potassium was obtained by deducting the available potassium from fixed potassium contents.

RESULTS AND DISCUSSION

Physico-chemical properties of soil

Relative proportion of sand, silt and clay fractions of soils ranged from 42.56 to 76.56 per cent (with a mean of 55.49 percent), 0.36 to 19.36 per cent (with a mean of 11.91 per cent) and 16.08 to 43.08 (with a mean of 32.60 per cent), respectively (Table 1). The texture of studied soils varied from moderately coarse to fine.The pH ranges from 7.2 to 8.52 with a mean value of 7.99, indicating

*Corresponding author, E-mail: kavitha.ssac@gmail.com

that soils were neutral to slightly alkaline in reaction.The Electrical Conductivity ranges from 0.14 to 1.52 dS m^{-1} with a mean value of 0.52 dS m^{-1} (Table 2).

The CEC ranged from 11.21 to 26.91 c mol (p+) kg^{-1} with a mean value of 18.21 c mol (p+) kg^{-1}. The organic carbon varied from 0.26 per cent to 0.94 per cent with a mean of 0.67 per cent (Table 2) indicating that most of the soils are belong to medium in organic carbon content.

Different forms of potassium in the selected soils

The water soluble potassium varied from 10.5 to 39.5 mg kg^{-1} with a mean value of 20.42 mg kg^{-1}. The available potassium varied from 69 to 431 mg kg^{-1} with a mean value of 189.60 mg kg^{-1}. The exchangeable potassium content varied from 48.5 to 393.5 mg kg^{-1} with a mean value of 169.18 mg kg^{-1} where asnon-exchangeable potassium ranged between 190.5 to 711 mg kg^{-1} with a mean value of 329.63 mg kg^{-1}. The fixed potassium in the selected soils varied from 261 to 1142 mg kg^{-1} with a mean amount of 519.23mg kg^{-1} (Table 3).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 and significant correlation with available K (r = 0.468**), exchangeable K (r = 0.386*), non-exchangeable K (r = 0.526**) and fixed K (r = 0.533**) whereas available K showed positive and significant correlation with exchangeable K (r = 0.996**), non-exchangeable K (r = 0.754**) and fixed K (r = 0.924**) (Table 4). Similar results were reported by Singh *et al. (*2010). Exchangeable K showed a positive and significant correlation with non-exchangeable K (r = 0.733**) and fixed K (r=0.910**). These results were in conformity with the findings of Islam *et al.* (1994), Das *et al.* (2000) and Subhash and Ali (2011).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).

Correlation coefficients between different forms of potassium and soil characteristics

Coefficients of correlations were worked out to assess the influence of soil properties on various forms of K (Table 5).

Among the different soil properties pH, CEC, organic carbon and clay showed the positive correlation with all forms whereas EC, $CaCO_3$ and sand showed negative correlation. Similar reports were made by Taleb *et al.* (2010). Available K showed positive correlation with CEC (r = 0.119), indicating that clay humus complex formed from increased organic matter provides more exchangeable sites and access to K (Basumatary and Borodoloi, 1992).

Exchangeable K showed positive relationship with clay (r = 0.273) but negative with EC (r = -0.096) and $CaCO_3$(r = -0.112).High amount of clay (r=0.273) played an important role in increasing the exchangeable K level by holding more potassium in the exchange sites thereby preventing it from leaching.

CONCLUSIONS

The study brings out the importance of potassic forms in the soil and positive correlations among themselves indicates the dynamic equilibrium among the forms of K and majority of potassium is found in fixed form which replenishes soil solution potassium. Hence, if potassium not adequately supplied during plant growth, fixed K depletes and helps in attaining sustainability on a long term basis. Among the different soil properties pH, CEC, organic carbon and clay per cent showed positive correlation with all forms of potassium, it indicating that soil properties are more influence on the exist of different forms of potassium.

REFERENCES

Basumatary, H and Bordoloi, P.K. 1992. Forms of potassium in some soils of Assam in relation to soil properties. *Journal of the Indian Society of Soil Science.* 40: 443-446.

Das, K., Sarkar, D and Nayak, D.C. 2000. Forms of potassium and their distribution in some soils of representing red and laterite ecosystem of West Bengal. *Journal of the Indian Society of Soil Science.* 16: 1-6.

Islam, Md., Sirjul, Kar, N.K., Musa, A.M and Eaqub, M. 1994. Efficiency of different methods of potassium determination in some selected soils of Bangladesh. *Journal of the Indian Society of Soil Science.* 42(3): 408-413.

Jackson, M.L. 1973. *Soil Chemical Analysis*. Oxford and IBH Publishing House, Bombay, pp 38.

Table 1. Particle size analysis and textural classes of the soils

S. No.	Village Name	Clay %	Silt %	Sand %	Texture
1	Nandipalli	16.08	7.36	76.56	Sandy loam
2	Kambalapalli	41.00	10.36	48.64	Sandy clay
3	Chennuru	33.08	15.36	51.56	Sandy clay loam
4	Yerraguntla	34.08	11.36	54.56	Sandy clay loam
5	Abdullapuram	35.08	2.36	62.56	Sandy clay
6	Bathunuru	37.08	9.36	53.56	Sandy clay
7	Bachapuram	33.18	12.36	54.46	Sandy clay loam
8	Gadivemula	34.08	11.36	54.56	Sandy clay loam
9	Nallagatla	39.08	16.36	44.56	Sandy clay
10	RARS,Nandyal	43.08	14.36	42.56	Clay
11	Padakandla	36.08	17.36	46.56	Sandy clay loam
12	Nagulavaram	31.08	0.36	68.56	Clay loam
13	Mandalluru	25.08	14.36	60.56	Sandy clay loam
14	M.C.Farm, College	19.00	12.36	68.64	Sandy loam
15	Rollapadu	37.08	13.36	49.56	Sandy clay
16	Korrapoluru	36.08	6.36	57.56	Sandy clay
17	Midthur	39.08	12.36	48.56	Sandy clay
18	Alaganuru	39.08	12.36	48.56	Sandy clay
19	Bollavaram	31.08	12.36	56.56	Sandy clay
20	Bereli	31.08	4.36	64.56	Sandy clay loam
21	Thellapuri	39.08	16.36	44.56	Sandy clay
22	Gorukallu	35.08	6.36	58.56	Sandy clay
23	Brahmanapalli	31.08	16.36	52.56	Sandy clay loam
24	AyyavariKoduru	31.08	4.36	64.56	Sandy clay loam
25	Pamulapadu	19.00	14.36	66.64	Sandy loam
26	Nehrunagar	34.08	11.36	54.56	Sandy clay loam
27	Parnapalle	29.78	15.96	54.26	Sandy clay loam
28	Machenipalle	25.08	18.36	56.56	Sandy clay loam
29	BandiAtmakuru	30.08	19.36	50.56	Sandy clay loam
30	Krishnaraopeta	33.08	18.36	48.56	Sandy clay loam
	Mean	**32.60**	**11.91**	**55.49**	
	Range	**16.08-43.08**	**0.36-19.36**	**42.56-76.56**	

Table 2. Physico-chemical properties of soils under investigation

S. No.	Village Name	pH	EC (dS m^{-1})	Organic Carbon (%)	$CaCO_3$ (%)	C.E.C C mol (p^+) kg^{-1}
1	Nandipalli	7.25	0.59	0.26	1.90	14.65
2	Kambalapalli	7.84	0.25	0.36	1.10	19.82
3	Chennuru	7.87	0.83	0.78	1.80	16.92
4	Yerraguntla	8.10	0.41	0.69	2.70	18.31
5	Abdullapuram	7.87	0.22	0.61	3.80	22.69
6	Bathunuru	8.07	1.52	0.46	2.50	17.31
7	Bachapuram	7.80	0.51	0.55	2.20	14.41
8	Gadivemula	8.26	0.87	0.90	4.20	20.76
9	Nallagatla	7.85	0.84	0.82	2.20	16.42
10	RARS,Nandyala	8.14	0.26	0.76	2.76	22.76
11	Padakandla	8.23	0.35	0.85	1.90	23.65
12	Nagulavaram	8.18	0.24	0.76	4.90	25.61
13	Mandalluru	7.97	0.79	0.45	2.90	14.43
14	M.C.Farm, College	7.77	0.19	0.46	1.13	11.53
15	Rollapadu	8.14	0.28	0.76	3.70	17.32
16	Korrapoluru	8.52	0.62	0.83	3.50	19.43
17	Midthur	8.29	0.61	0.49	3.60	18.29
18	Alaganuru	8.06	0.31	0.78	1.60	17.43
19	Bollavaram	8.12	0.67	0.91	3.80	26.91
20	Bereli	8.08	0.38	0.81	1.10	15.32
21	Thellapuri	8.17	0.31	0.86	3.85	23.41
22	Gorukallu	7.99	0.42	0.94	4.94	24.81
23	Brahmanapalli	7.78	1.01	0.69	1.97	18.21
24	AyyavariKoduru	7.90	0.47	0.64	1.41	14.21
25	Pamulapadu	7.20	0.14	0.53	2.90	15.31
26	Nehrunagar	8.05	0.51	0.93	1.70	15.91
27	Parnapalle	7.30	0.37	0.44	3.10	14.91
28	Machenipalle	8.22	0.75	0.51	2.10	12.48
29	BandiAtmakuru	8.50	0.25	0.62	3.50	11.21
30	krishnaraopeta	8.11	0.51	0.71	3.90	21.91
	Mean	**7.99**	**0.52**	**0.67**	**2.76**	**18.21**
	Range	**7.2-8.52**	**0.14-1.52**	**0.26-0.94**	**1.1-4.94**	**11.21-26.91**

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	Nandipalli	16.5	103.0	86.5	237.0	340
2	Kambalapalli	24.5	283.0	258.5	449.0	732
3	Chennuru	13.5	144.0	130.5	247.0	391
4	Yerraguntla	31.5	221.0	189.5	348.0	569
5	Abdullapuram	11.0	115.0	104.0	239.0	354
6	Bathuunuru	15.0	157.0	142.0	264.0	421
7	Bachapuram	15.0	123.0	108.0	276.0	399
8	Gadivemula	15.5	243.5	228.0	277.5	521
9	Nallagatla	30.5	287.5	257.0	344.5	632
10	RARS, Nandyal	13.5	194.5	181.0	297.5	492
11	Padakandla	17.5	207.5	190.0	385.5	593
12	Nagulavaram	12.0	128.0	116.0	311.0	439
13	Mandalluru	16.0	111.0	95.0	367.0	478
14	M.C.Farm, College	19.0	369.0	350.0	315.0	684
15	Rollapadu	32.5	209.5	177.0	363.5	573
16	Korrapoluru	15.5	206.0	190.5	286.0	492
17	Midthur	37.5	431.0	393.5	711.0	1142
18	Alaganuru	23.5	169.0	145.5	269.0	438
19	Bollavaram	39.5	199.5	160.0	343.5	543
20	Bereli	23.5	234.0	210.5	439.0	673
21	Thellapuri	10.5	198.5	188.0	392.5	591
22	Gorukallu	17.0	185.5	168.5	347.5	533
23	Brahmanapalli	28.0	140.5	112.5	322.5	463
24	Ayyavari Koduru	14.0	203.0	189.0	379.0	582
25	Pamulapadu	13.0	171.5	158.5	258.5	430
26	Nehrunagar	20.5	184.5	164.0	336.5	521
27	Parnapalle	23.0	101.0	78.0	266.0	367
28	Machenipalle	15.5	70.5	55.0	190.5	261
29	BandiAtmakuru	20.5	69.0	48.5	222.0	291
30	Krishnaraopeta	27.5	228.0	200.5	404.0	632
	Mean	**20.42**	**189.60**	**169.18**	**329.63**	**519.23**
	Range	**10.5-39.5**	**69-431**	**48.5-393.5**	**190.5-711**	**261-1142**

Table 4. Inter Correlations between different forms of potassium

	Water soluble K	Available K	Exchangeable K	Non-Exchangeable K	Fixed K
Water soluble K	1.000				
Available K	0.468**	1.000			
Exchangeable K	0.386*	0.996**	1.000		
Non-Exchangeable K	0.526**	0.754**	0.733**	1.000	
Fixed K	0.533**	0.924**	0.910**	0.948**	1.000

Table 5. Correlations between different forms of potassium and soil characteristics

	Water soluble K	Available K	Exchangeable K	Non-Exchangeable K	Fixed K
pH	0.121	0.169	0.164	0.233	0.217
EC	0.084	-0.084	-0.096	-0.078	-0.086
OC	0.084	0.095	0.091	0.039	0.069
$CaCO_3$	-0.002	-0.107	-0.112	0.032	-0.034
CEC	0.059	0.119	0.119	0.217	0.184
Clay %	0.199	0.281	0.273	0.363*	0.348
Silt %	0.253	-0.036	-0.063	-0.050	-0.047
Sand %	-0.310	-0.201	-0.178	-0.257	-0.247

* Significant at 0.05 per cent level
** Significant at 0.01 per cent level

Kanwar, J.S and Grewal, J.S. 1966. The relationship between forms of soil potassium and particle size. *Journal of the Indian Society of Soil Science.* 14: 221 -225.

Lalitha, M. and Dakshinamoorthy, M. 2014. Forms of soil potassium-a review. *Agricultural reviews.* 35 (1): 64-68.

Prasad, J. 2010. Forms of potassium in shallow soils of different origin and land uses in Nagpur district of Maharastra. *Journal of the Indian Society of Soil Science.* 58 (3): 327-330.

Singh, J.P., Singh, S and Singh, V. 2010. Soil potassium fractions and response of cauliflower and onion to potassium. *Journal of the Indian Society of Soil Science. 58(4): 84-387.*

Subhash, C and Ali, T. 2011. Potassium releasing capacity in some soils of Anantnag district of Kashmir. *Universal Journal of Environmental Research and Technology.* 1(3): 373-375.

Taleb, S. A., Mondal and SiddiquIM, Z. 2010. Distribution of different farms of potassiumin lateritic soils of Birbhum. West Bengal *Progressive Agriculture*. 10: 134-137.

Wood, L.K and Turk, E.E.D. 1941. The absorption of potassium in soil in non-replicable forms. *Proceedings of Soil Science Society of America*. 5: 152-161.