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Potassium Fractions in Different Rice based Cropping Systems of Bapatla District, Andhra Pradesh

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ABSTRACT

An investigation was carried out to study the different fractions of potassium in rice based cropping systems (*viz.,* Rice-Pulse, Rice-Groundnut, Rice-Maize and Rice-Sorghum cropping systems) of Bapatla district. The mean values of water-soluble K, exchangeable K, non-exchangeable K, fixed-K and total K were 29.3, 147.2, 702, 881 mg kg^{-1} and 16.55 g kg^{-1} respectively in Rice-Pulse cropping system. The mean values of water-soluble K, exchangeable K, non-exchangeable K, fixed-K and Total K were 16.8, 104.9, 423, 545 mg kg^{-1} and 8.90 g kg^{-1} respectively in Rice-Groundnut cropping system. The mean values of water-soluble K, exchangeable K, non-exchangeable K, fixed-K and Total K were 22.6, 129.3, 662, 814 mg kg^{-1} and 15.95 g kg^{-1} respectively in Rice-Maize cropping system. The mean values of water-soluble K, exchangeable K, non-exchangeable K, fixed-K and Total K were 29.4, 154.0, 707, 891 mg kg^{-1} and 17.00 g kg^{-1} respectively in Rice-Sorghum cropping system. The order of dominance of different fractions of potassium was total K> fixed K > non-exchangeable K > exchangeable K > water soluble K. Different fractions of potassium had a significant and positive relationship among themselves indicating the dynamic equilibrium among themselves.

Key Words: *Cropping systems, Dynamic equilibrium and Potassium fractions*

Potassium is one of the major nutrients along with nitrogen and phosphorus and plays a major role in plant metabolism. Potassium exists in different forms in soil viz., water soluble, exchangeable, non-exchangeable, mineral and lattice K. But these forms are not homogeneously distributed in soils. The amount in soil depends on the parent material, degree of weathering, K addition through manures and fertilizers and losses due to crop removal, erosion and leaching. Usually, the amounts of fixed K present in the soil is high as compared to water soluble and exchangeable K. Rice – based cropping systems form an integral part of agriculture. Several intensive rice - based cropping systems have been identified and are being practiced by the farmers. The impact of cropping with or without K application is reflected not only in crop yields and K uptake but also in the amounts of K in different fractions in the soil. The present investigation was carried out to study the different fractions of potassium in rice-based cropping systems of Bapatla district.

MATERIAL AND METHODS

Different locations were identified in four rice based cropping systems based on predominance of cropping systems, (viz. Rice-Pulse, Rice-Groundnut, Rice-Maize and Rice-Sorghum cropping systems) in Bapatla district of Andhra Pradesh. Surface soil samples were collected from 40 locations and samples were analysed for potassium fractions. Each sample was then sub-sampled, by quartering and finally a representative soil sample was preserved in a polythene bag for laboratory analysis. Water soluble potassium was determined using flame photometer in 1:5 soil: water extract, after 5 minutes shaking (Kanwar and Grewal, 1966). The available potassium was determined in neutral normal ammonium acetate extract (1:5 soil: extractant) , after 5 minutes of 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 with 1 N HNO_3 (1:10 soil: acid ratio) for 10 minutes (Wood and DeTurk, 1941). The non-exchangeable potassium was obtained by deducting the available potassium from fixed potassium contents. The total K content in soil was determined by sodium carbonate fusion method and the K dissolved in HCl was estimated by Flame photometer (Page *et al.* 1982). Simple correlations were worked out between different forms of potassium by SPSS software.

RESULTS AND DISCUSSION

Water-soluble potassium

The water-soluble K in Rice-Pulse is 24.0-35.0 mg kg^{-1}, Rice-Groundnut is 13.7-22.4 mg kg^{-1}, Rice-Maize is 15.2-38.0 mg kg^{-1} and Rice-Sorghum 17.6-40.8 mg kg^{-1} and with the mean values of 29.3, 16.8, 22.6 and 29.4 mg kg^{-1} in Rice-Pulse, Rice-Groundnut, Rice-Maize and Rice-Sorghum cropping systems, respectively. In present study area it was observed that mean values of water-soluble K are more in fine textured soils than coarse textured soils due to high leaching losses of applied or native soil potassium in sandy soils. The results are in conformity with those of Rao and Srinivas (2017), Harsha and Jagadeesh (2017).

Exchangeable Potassium

The exchangeable K in Rice-Pulse is 106.6-179.2 mg kg^{-1}, Rice-Groundnut is 88.0-141.1 mg kg^{-1}, Rice-Maize is 104.0-183.0 mg kg^{-1} and Rice-Sorghum cropping system is 109.6-195.5 mg kg^{-1} with the mean values of 147.2, 104.9, 129.3 and 154.0 mg kg^{-1} in Rice-Pulse, Rice- Groundnut, Rice-Maize and Rice-Sorghum cropping systems, respectively. It was observed that mean exchangeable potassium is higher in black soils which might be due to the fact that black soils are rich in organic matter content and in general, dominated by 2:1 type of clay minerals which offered more exchange sites for K than sandy soils. Similar findings were observed by Prasad *et al.* (2015) and Swamanna *et al.* (2015).

Non-exchangeable Potassium

The non-exchangeable K in Rice-Pulse is 475-938 mg kg^{-1}, Rice-Groundnut is 359-567 mg kg^{-1}, Rice-Maize is 472-935 mg kg^{-1} and Rice-Sorghum cropping system is 504-1055 mg kg^{-1} with the mean values of 702, 423, 662 and 707 mg kg^{-1} in Rice-Pulse, Rice- Groundnut, Rice-Maize and Rice-Sorghum cropping systems, respectively. In the study area, it was observed that mean non-exchangeable potassium is higher in black soils might be due the K in between adjacent tetrahedral layers of dioctahedral and trioctahedral clay minerals. Similar findings were found by Karwade *et al.* (2020) and Rajeevana *et al.* (2022).

Fixed K

The fixed K in Rice-Pulse is 641-1151 mg kg^{-1}, Rice-Groundnut is 463-731 mg kg^{-1}, Rice-Maize is 591-1156 mg kg^{-1} and Rice-Sorghum cropping system is 631-1289 mg kg^{-1} with the mean values of 881, 545, 814 and 891 mg kg^{-1} in Rice-Pulse, Rice- Groundnut, Rice-Maize and Rice-Sorghum cropping systems, respectively. In the study area, Clay soils have more fixed K due to the fixation of K in layers of clay minerals. Sandy soils have less fixed K due to less organic matter and due to leaching of K. Similar findings were noticed by Prasad *et al.* (2015) and Swamanna *et al.* (2015) were noticed.

Total K

The total K in Rice-Pulse is 12.02-21.70 g kg^{-1}, Rice-Groundnut is 7.47-11.76 g kg^{-1}, Rice-Maize is 11.73-22.50 g kg^{-1} and Rice-Sorghum cropping system is 11.84-24.60 g kg^{-1} with the mean values of 16.55, 8.90, 15.95 and 17.00 mg kg^{-1} in Rice-Pulse, Rice- Groundnut, Rice-Maize and Rice-Sorghum cropping systems, respectively Clay soils have more total k due to the rich K bearing minerals in their lattice structure and their quantity present in soils. Similar findings ware recorded by Misal *et al.* (2020).

The mean values of potassium fractions in soils of different cropping systems in present study area were in the order of Rice-Sorghum cropping system followed by Rice-Pulse cropping system, Rice-Maize cropping system and Rice-Groundnut cropping system.

Correlation coefficients (r) among the fractions of potassium:

All the potassium fractions are significantly positively correlated with each other. Non exchangeable K had positive and significant relationship with all other K fractions indicating the existence of equilibrium between different forms of K and a depletion of one form is replenished by the other forms of potassium. Similar findings were recorded by Prasad *et al.* (2015) and Alam and Singh (2021).

Table 1. Potassium fractions of soils in rice based cropping systems of Bapatla

S. No	Villages	Water-soluble K (mg kg^{-1})	Exchangeable K (mg kg^{-1})	Non-Exchangeable K (mg kg^{-1})	Fixed K (mg kg^{-1})	Total K (g kg^{-1})
A. RICE-PULSE CROPPING SYSTEM						
1	Arepalli	24.4	143.4	638	805	15.08
2	Illvaram	35.0	178.2	938	1151	21.70
3	Peddapalli	29.6	148.2	475	665	12.54
4	Bethapudi	34.2	157.4	757	948	17.75
5	Pallepatla	24.0	106.7	501	641	12.02
6	Modukuru	30.2	146.5	742	919	17.31
7	Tumella	24.2	131.7	650	806	15.12
8	Vaddevaripalem	31.6	155.5	786	973	18.26
9	Eepuru	32.3	155.9	800	988	18.62
10	Jillelamudi	27.9	148.1	737	913	17.09
Mean		**29.3**	**147.2**	**702**	**881**	**16.55**
Range		**24.0-35.0**	**106.6-179.2**	**475-938**	**641-1151**	**12.02-21.70**
B. RICE-GROUNDNUT CROPPING SYSTEM						
11	Cherukupalli	13.7	94.3	380	488	7.97
12	Arepalli	21.0	135.3	556	713	11.58
13	Pallepatla	14.7	102.1	421	537	9.76
14	Kuchinapudi	15.4	88.0	360	463	7.47
15	Chinnamatlapudi	22.4	141.1	567	731	11.76
16	Peddapalli	15.5	90.9	380	486	7.87
17	Bhavanamvaripalem	17.4	115.7	439	573	9.16
18	Thummalapalli	14.3	90.7	359	464	7.47
19	Perali	17.4	99.7	404	521	8.43
20	Chandole	15.8	91.3	362	469	7.50
Mean		**16.8**	**104.9**	**423**	**545**	**8.90**
Range		**13.7-22.4**	**88.0-141.1**	**359-567**	**463-731**	**7.47-11.76**
C. RICE-MAIZE CROPPING SYSTEM						
21	Gullapalli	23.0	141.8	625	789	15.55
22	Govada	20.4	118.4	678	817	15.82
23	Bethapudi	26.9	144.2	705	876	17.16
24	Bhattiprolu	19.4	119.7	641	780	15.42
25	Kodiparru	25.9	132.6	747	906	17.56
26	Amruthalur	15.2	104.2	472	591	11.73
27	Tsunduru	17.7	104.0	504	626	12.35
28	Gudipudi	20.4	126.5	705	852	16.74
29	Ananthavaram	38.0	183.0	935	1156	22.50
30	Bhartipudi	19.2	118.5	613	750	14.68
Mean		**22.6**	**129.3**	**662**	**814**	**15.95**
Range		**15.2-38.0**	**104.0-183.0**	**472-935**	**591-1156**	**11.73-22.50**
D. RICE-SORGHUM CROPPING SYSTEM						
31	Addepalli	28.3	146.9	790	965	18.51
32	Illavaram	24.1	139.2	722	885	17.10
33	Kodiparru	38.5	195.5	1055	1289	24.60
34	Chavali	40.8	172.3	579	792	15.33
35	Tsunduru	18.6	117.9	547	684	13.07
36	Pedapudi	32.1	167.1	676	875	16.49
37	Kuchipudi	17.6	109.6	504	631	11.84
38	Poondla	23.4	152.8	544	720	13.69
39	Ananthavaram	40.3	184.8	923	1148	21.85
40	Chilumuru	30.3	154.2	735	919	17.53
Mean		**29.4**	**154.0**	**707**	**891**	**17.00**
Range		**17.6-40.8**	**109.6-195.5**	**504-1055**	**631-1289**	**11.84-24.60**

Table 2: Correlation coefficients (r) between potassium fractions and potassium release parameters in Rice-Pulse cropping system

Potassium parameters	Water Soluble-K	Exchangeable-K	Non-Exchangeable K	Fixed-K	Total-K
Water soluble-K	1.000				
Exchangeable-K	0.877**	1.000			
Non-exchangeable K	0.764*	0.782**	1.000		
Fixed-K	0.804**	0.832**	0.986**	1.000	
Total-K	0.805**	0.834**	0.985**	0.987**	1.000

Table 3: Correlation coefficients (r) between potassium fractions and potassium release parameters in Rice-Groundnut cropping system

Potassium parameters	Water Soluble-K	Exchangeable-K	Non-Exchangeable K	Fixed-K	Total-K
Water soluble-K	1.000				
Exchangeable-K	0.925**	1.000			
Non-exchangeable K	0.925**	0.989**	1.000		
Fixed-K	0.931**	0.993**	0.999**	1.000	
Total-K	0.857**	0.963**	0.981**	0.978**	1.000

Table 4: Correlation coefficients (r) between potassium fractions and potassium release parameters in Rice-Maize cropping system

Potassium parameters	Water Soluble-K	Exchangeable-K	Non-Exchangeable K	Fixed-K	Total-K
Water soluble-K	1.000				
Exchangeable-K	0.967**	1.000			
Non-exchangeable K	0.928**	0.890**	1.000		
Fixed-K	0.955**	0.926**	0.992**	1.000	
Total-K	0.952**	0.924**	0.991**	0.993**	1.000

Table 5: Correlation coefficients (r) between potassium fractions and potassium release parameters in Rice-Sorghum cropping system

Potassium parameters	Water Soluble-K	Exchangeable-K	Non-Exchangeable K	Fixed-K	Total-K
Water Soluble-K	1.000				
Exchangeable-K	0.931**	1.000			
Non-Exchangeable K	0.690*	0.746*	1.000		
Fixed-K	0.761*	0.819**	0.992**	1.000	
Total-K	0.762*	0.817**	0.991**	0.993**	1.000

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