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RESEARCH ARTICLE :

Fixation and release pattern of potassium under graded levels of potassium application in soils of Kurnool district

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SUMMARY : An incubation was carried out in ten surface soil samples (0-15 cm) to study the fixation and release pattern of K under the influence of different levels of potassium in soils of Kurnool district. The soils under study were moderately coarse to fine in texture, neutral to slightly alkaline, non saline and non-calcareous. Water soluble potassium content increased from 0 to 14 DAI and later on gradually decreased from 21 DAI to 120 DAI in fertilizer treatments. However, in control water soluble K content gradually decreased from 0 to 120 DAI but still existence of water soluble form upto 120 DAI. Available K content increased in control from 0 to 14 DAI whereas in fertilized plots (from 30 to 90 kg K_2O ha^{-1}) increased upto 21 DAI, later on gradually decreased upto 120 DAI. Unlike water soluble and available potassium mean fixed potassium gradually increased upto 0 to 120 DAI in fertilizer treatments, whereas in control mean fixed form of K decreased gradually from 0 to 120 DAI.

KEY WORDS :
Soil, Potassium, DAI, Water soluble

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BACKGROUND AND OBJECTIVES

Potassium is one of major and essential plant nutrient has instrumental role in plant nutrition and physiology. Potassium fixation and release in soil are important issues in long term sustainability of cropping systems.

Potassium fixation in soil is the phenomenon of conversion of exchangeable and water soluble K into non exchangeable-K which is not readily taken up by plants (Mortlanad, 1961). InPotassium fixation is process the soluble K from the external source will come into solution due to its solubility thus increasing the intensity of K in soil solution and later the applied K will enter into non-exchangeable sites thus reducing the amount of K in soil solution. Mechanism of K-fixation is preceded by moving the K ions from edges and surface to the interior of soil mineral fabric and increasing the amount of K influenced by the ion diffusion (Chakravorty and Patnaik, 1990). Fixed K becomes available to plants over longer period of time upon depletion of

water soluble and exchangeable K (Patra and Debanath,1998).The variability in K fixation in soil indirectly influences the response of crops to added K fertilizer and the potassium requirement to maintain the soil available K status for optimum plant growth (Chakravorty and Patnaik,1990).Hence, it is essential to evaluate the potassium fixation capacity of soils based on which, the quantity of K-fertilizers to be applied can be described to meet the crop requirements.

RESOURCES AND METHODS

The study was undertaken in the Department of Soil Science and Agricultural chemistry, Agricultural College, Mahanandi during the years of 2015-16. The soil samples collected were air dried and passed through 2mm sieve. Each sample was then sub-sampled, by quartering and finally a representative soil sample was preserved in a polythene bag for laboratory analysis.The selected soils were analyzed for their initial soil properties. The particle size analysis was carried out by Bouyoucous hydrometer method (Piper, 1966). The pH and EC were determined in 1:2 soils: water suspension using pH meter and EC meter (Jackson, 1973). The free $CaCO_3$ content was determined as per procedure given by (Piper,1966). 500 gm of processed soil samples were taken in plastic dishes and supplied with 0, 30, 60 and 90 kg K_2O ha^{-1}. The plastic dishes were kept in laboratory for incubation upto 120 days at field capacity. Water soluble, available and fixed K content were determined at 0, 7, 14, 21, 35, 50, 65, 80 and 120 days after incubation. Water soluble potassiumwas determined in 1:5 soil: water extract, after 5 minutes equilibration and potassium in the aliquot was determined by flame photometer (Kanwar and Grewal, 1966). Potassium was extracted with *N*N NH_4OAc (soil: extractant ratio of 1:5 equilibrating for 5 min) and the potassium in the aliquot was determined by flame photometer (Jackson, 1973). The potassium was estimated by boiling the soil with 1*N* HNO_3 (soil: acid ratio 1:10 for 10 minutes) and the K content in the aliquot was determined by flame photometer (Wood and DeTurk, 1941).

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Water soluble potassium release pattern :

The data on water soluble form in the selected 10 villages at different days after incubation are presented in the Tables (1, 2, 3 and 4) and the mean water soluble form of 10 villages at DAI depicted in the Fig. 1. The results indicated that water soluble K content at 0 kg K_2O ha^{-1} decreased gradually from 0 to 120 DAI in all 10 soils whereas in fertilizer treatments (from 30 to 90 kg K_2O ha^{-1}) water soluble potassium content increased from 0 to 14 DAI and later on gradually decreased. However mean extractable water soluble K content decreased in control but still existence of water soluble form upto 120 DAI indicated existence of dynamic equilibrium among different forms. Water soluble K content increased at different doses from 30 to 90 kg K_2O ha^{-1} compared to control treatment in all soils through out the period of incubation.

Table 1 : Water soluble potassium release pattern in experimental soils at 0 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	39	35	30	27	23	18	15	12	10
Venkateswarapuram	48	42	38	31	26	21	18	14	11
Kouluru	52	48	40	34	28	26	20	16	13
Kanala	26	24	21	18	15	13	11	9	6
Kaminenipalli	24	22	19	16	13	10	9	8	6
Yerragudidinna	24	21	19	16	13	12	10	9	8
M.C. Farm (mai)	45	39	35	29	24	20	17	15	12
Mahanandi	35	30	25	21	18	15	13	10	7
Battaluru	30	26	21	18	16	14	10	9	6
M.C.Farm (g.nut)	32	28	25	21	17	15	12	9	8
Mean	36	32	27	23	19	16	14	11	9

Available potassium release pattern :

The data on available potassium in the selected 10 villages at different days after incubation is presented in the Tables (5, 6, 7 and 8) and the mean water soluble form of 10 villages at different days after incubation is depicted in the Fig. 2. Available K content increased in control from 0 to 14 DAI whereas in fertilized treatments (from 30 to 90kg K_2O ha^{-1}) it increased upto 21 DAI.

Table 2 : Water soluble potassium release pattern in experimental soils at 30 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	44	49	55.5	51	44	39	31	27	21
venkateswarapuram	52	57	63	55	47	42	36	30	24
Kouluru	56	62	73	65	58	51	42	34	28
Kanala	31	38	44	40	36	31	27	21	14
Kaminenipalli	19	25	32	28	24	19	16	11	9
Yerragudidinna	24	33	42	38	28	24	19	15	10
M.C.Farm(mai)	45	52	59	51	45	39	34	28	23
Mahanandi	35	42	51	46	39	31	26	21	19
Battaluru	30	39	46	40	34	28	21	17	15
M.C.Farm(g.nut)	32	43	52	45	26	29	21	17	13
Mean	37	44	52	46	38	33	27	22	18

Table 3 : Water soluble potassium release pattern in experimental soils at 60 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	75	90	110	98	88	75	69	57	43
Venkateswarapuram	101	110	121	117	96	87	75	57	49
Kouluru	109	126	149	126	118	98	81	65	54
Kanala	58	74	81	75	70	61	53	41	26
Kaminenipalli	36	48	61	52	44	32	28	22	18
Yerragudidinna	44	68	86	74	56	48	33	27	20
M.C.Farm(mai)	88	102	120	101	87	76	66	54	42
Mahanandi	68	82	100	90	76	60	48	36	32
Battaluru	58	76	88	78	66	54	40	32	28
M.C.Farm(g.nut)	64	84	102	90	70	60	46	34	26
Mean	70	86	102	90	77	65	54	43	34

Table 4 : Water soluble potassium release pattern in experimental soils at 90 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	128	140	157	149	129	115	93	80	61
Venkateswarapuram	151	166	181	163	141	126	108	90	72
Kouluru	166	184	260	195	174	153	126	102	84
Kanala	91	114	130	120	106	90	77	60	41
Kaminenipalli	56	73	94	81	70	54	46	31	25
Yerragudidinna	70	26	124	112	84	70	55	42	28
M.C.Farm (mai)	130	154	175	153	135	115	102	84	67
Mahanandi	100	128	155	138	117	93	76	63	55
Battaluru	92	121	140	120	96	80	58	47	41
M.C.Farm (g.nut)	96	132	154	135	106	85	60	47	36
Mean	108	124	157	137	116	98	80	65	51

Later there was a gradual decrease. This clearly indicated that available K content 7 days more available in fertilized treatments than the control.

The available K content increased with increasing fertilizer doses from 30 to 90kg K_2O ha^{-1} from 0 to 120 DAI in all soils through out the period of incubation.

Fixed potassium release pattern :

The data on fixed potassium in the selected 10 villages at different days after incubation is presented in

Table 5 : Available potassium release pattern in experimental soils at 0 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	281	268	256	263	275	290	282	273	203
Venkateswarapuram	392	372	355	372	394	406	396	352	276
Kouluru	495	446	393	420	460	472	389	292	172
Kanala	272	262	246	258	263	278	263	243	164
Kaminenipalli	102	90	78	63	92	106	99	88	76
Yerragudidinna	142	136	128	135	144	147	138	117	96
M.C.Farm(mai)	352	306	285	310	349	362	344	310	286
Mahanandi	225	205	185	198	210	231	211	197	112
Battaluru	203	182	152	178	190	209	202	181	159
M.C.Farm(g.nut)	214	190	170	186	202	211	201	196	102
Mean	268	246	225	238	258	271	253	225	165

Table 6 : Available potassium release pattern in experimental soils at 30 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	292	443	513	563	509	441	380	332	276
venkateswarapuram	410	679	712	739	589	546	506	446	398
Kouluru	505	856	898	931	739	685	631	560	539
Kanala	282	430	453	476	495	427	358	309	271
Kaminenipalli	103	254	269	290	301	276	242	231	209
Yerragudidinna	154	330	353	376	402	276	241	210	180
M.C.Farm(mai)	361	621	642	668	691	568	531	460	430
Bukkapuram	229	261	280	296	307	249	229	201	175
Mahanandi	210.5	289	311	318	332	251	224	194	173
M.C.Farm(g.nut)	220	306	328	343	358	277	238	215	199
Mean	277	447	476	500	472	400	358	316	285

Table 7 : Available potassium release pattern in experimental soils at 60 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	302	426	486	546	433	343	250	150	105
Venkateswarapuram	419	898	965	1019	719	633	552	432	402
Kouluru	513	1065	1149	1216	705	597	492	342	299
Kanala	289	518	564	611	647	511	371	323	260
Kaminenipalli	111	413	434	478	500	450	381	359	316
Yerragudidinna	159	466	512	564	586	335	266	205	171
M.C.Farm(mai)	368	769	811	867	914	666	592	449	389
Mahanandi	237	301	339	371	393	267	226	210	169
Battaluru	218	429	474	486	515	353	300	241	201
M.C.Farm(g.nut)	228	400	445	475	509	347	269	224	193
Mean	284	569	618	663	592	450	370	294	251

the Tables (9,10,11 and 12) and the mean fixed potassium of 10 villages at different days after incubation is depicted in the Fig. 3. Unlike water soluble and available form, mean fixed potassium gradually increased upto 120 DAI in fertilizer treatments whereas mean fixed form of K in control decreased gradually from 0 to 120 DAI, indicating the existence of dynamic equilibrium among themselves so that non exchangeable form content

Table 8 : Available potassium release pattern in experimental soils at 90 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	313	953	1043	1133	964	829	637	479	333
Venkateswarapuram	427	1084	1185	1266	816	691	540	315	265
Kouluru	521	1349	1476	1577	1002	799	648	423	358
Kanala	296	640	709	778	833	629	419	348	258
Kaminenipalli	119	554	586	651	684	609	506	472	407
Yerragudidinna	167	576	645	723	758	382	278	187	136
M.C.Farm(mai)	376	977	1040	1124	1194	778	889	674	584
Mahanandi	244	340	423	470	503	315	254	173	128
Battaluru	226	462	529	552	595	353	243	154	101
M.C.Farm(g.nut)	240	498	565	610	661	418	302	234	187
Mean	293	743	820	888	801	580	472	346	276

Table 9 : Fixed form of potassium release pattern in experimental soils at 0 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	576	516	487	421	386	326	285	235	175
Venkateswarapuram	763	721	685	613	563	507	481	416	369
Kouluru	880	826	778	711	692	623	574	503	466
Kanala	490	427	385	304	261	210	175	115	78
Kaminenipalli	322	290	275	221	168	117	96	75	54
Yerragudidinna	396	354	286	219	186	115	92	80	66
M.C.Farm(mai)	653	586	507	476	413	386	304	277	201
Mahanandi	410	376	304	289	207	178	117	86	65
Battaluru	337	292	273	211	158	113	93	68	59
M.C.Farm(g.nut)	373	324	273	201	165	103	87	60	56
mean	520	471	425	367	320	268	230	192	159

Table 10 : Fixed form of potassium release pattern in experimental soils at 30 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	592	662	749	809	879	910	996	1085	1146
venkateswarapuram	793	975	1010	1034	1102	1196	1287	1398	1459
Kouluru	908	1165	1205	1256	1333	1414	1494	1566	1619
Kanala	526	570	621	660	721	788	830	889	923
Kaminenipalli	384	472	561	642	734	846	952	1068	1181
Yerragudidinna	491	503	598	684	778	891	1004	1116	1218
M.C.Farm(mai)	689	880	929	981	1086	1145	1210	1277	1320
Mahanandi	436	486	556	620	672	736	821	858	928
Battaluru	356	400	460	607	663	723	797	842	879
M.C.Farm(g.nut)	396	467	521	559	616	663	743	769	832
Mean	557	658	721	785	858	931	1013	1087	1151

Table 11 : Fixed form of potassium release pattern in experimental soils at60 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	752	832	921	1011	1102	1191	1303	1416	1520
Venkateswarapuram	926	1003	1094	1186	1271	1383	1492	1603	1714
Kouluru	1019	1106	1191	1282	1371	1486	1591	1710	1833
Kanala	654	743	832	926	1016	1125	1232	1343	1452
Kaminenipalli	402	496	584	682	772	884	986	1094	1210
Yerragudidinna	445	538	626	718	803	917	1022	1137	1234
M.C.Farm(mai)	856	948	1036	1128	1214	1323	1435	1542	1658
Mahanandi	482	572	651	744	836	947	1061	1176	1287
Battaluru	414	502	592	686	786	892	1023	1137	1251
M.C.Farm(g.nut)	494	583	671	763	874	983	1106	1224	1336
Mean	644	732	820	913	1005	1113	1225	1338	1450

Table 12 : Fixed form of potassium release pattern in experimental soils at 90 Kg K_2O ha^{-1} in during incubation period

Village name	Days after incubation								
	0	7	14	21	35	50	65	80	120
RARS Nandyal (rice)	989	1076	1149	1206	1356	1449	1573	1692	1832
Venkateswarapuram	1126	1208	1289	1396	1506	1611	1723	1842	1966
Kouluru	1219	1294	1376	1463	1578	1692	1806	1924	2038
Kanala	874	968	1043	1132	1229	1342	1468	1576	1685
Kaminenipalli	484	582	659	756	839	1016	1174	1270	1436
Yerragudidinna	549	680	756	842	956	1052	1196	1292	1426
M.C.Farm(mai)	1065	1148	1236	1316	1422	1546	1663	1792	1906
Mahanandi	650	744	836	913	1024	1133	1247	1336	1469
Battaluru	614	702	796	881	985	1092	1203	1323	1446
M.C.Farm(g.nut)	694	788	872	966	1032	1194	1326	1431	1566
Mean	826	919	1001	1087	1193	1313	1438	1548	1677

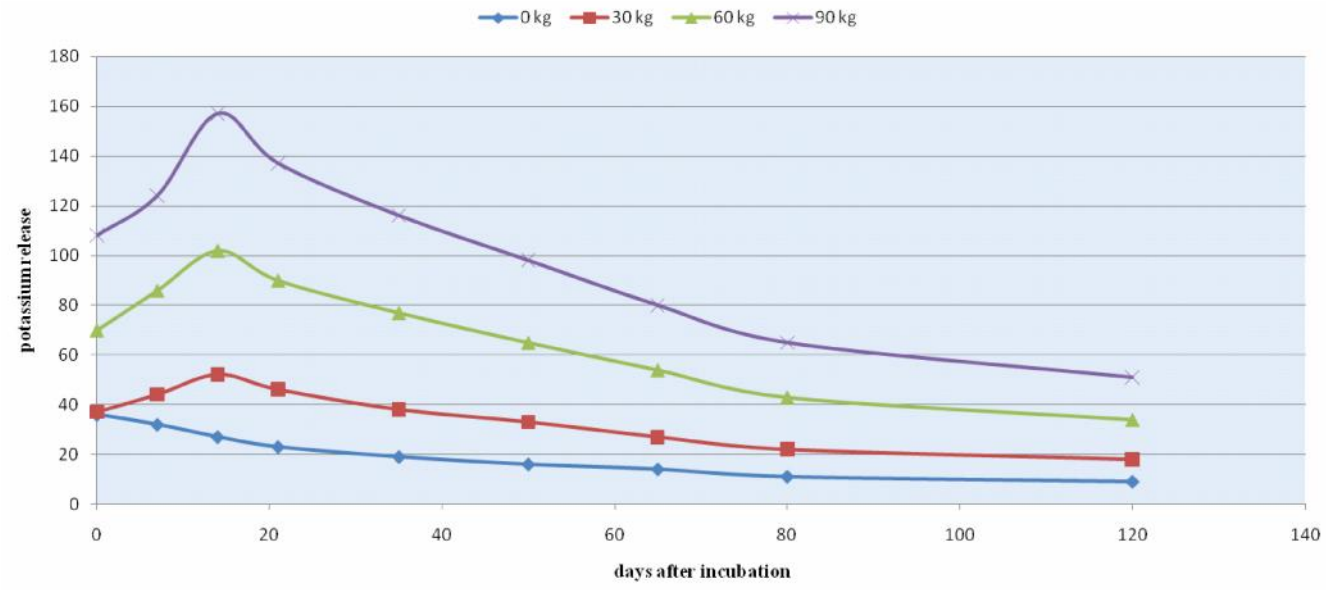

Fig. 1 : Mean water soluble potassium release pattern at different levels of fertilizers

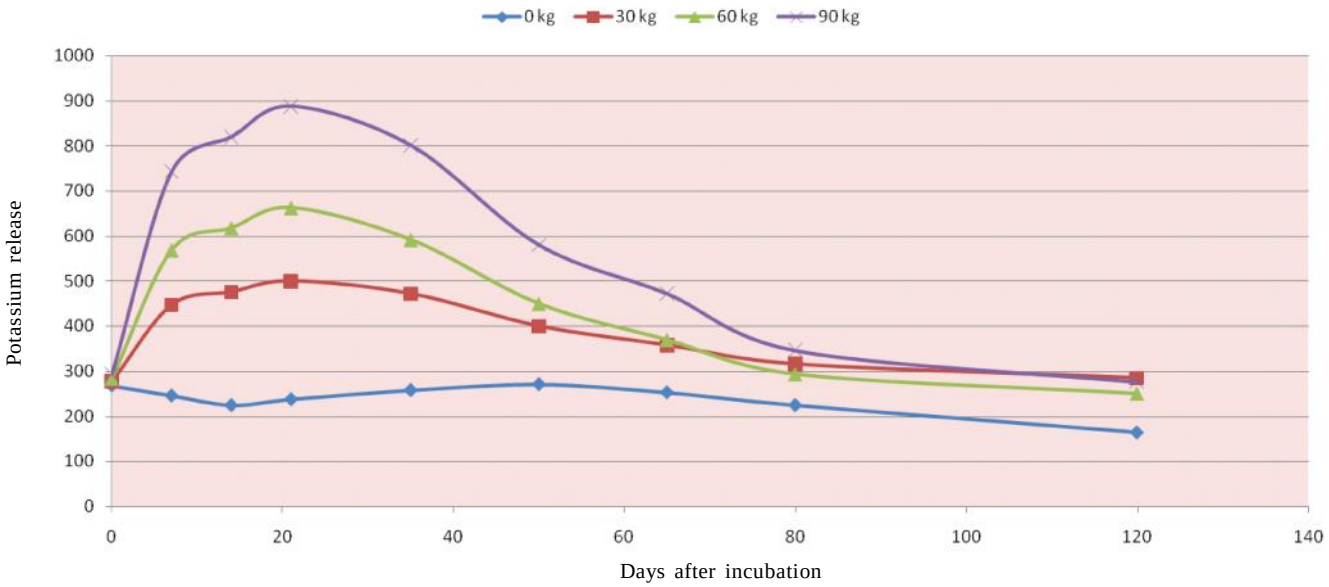

Fig. 2 : Mean available potassium release at different levels of fertilizer

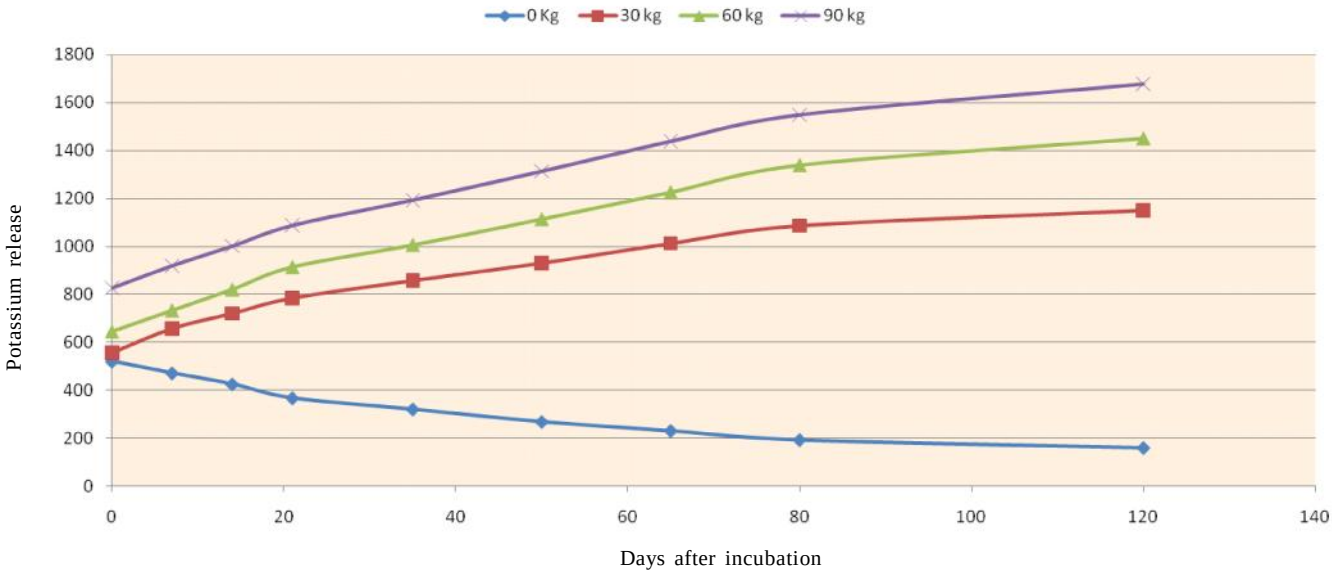

Fig. 3 : Mean fixed potassium release at different levels of fertilizer

decreases and it becomes available. The fixation of K increased with increasing levels of K from the 30 to 90 kg K_2O ha^{-1}.The increased added K fixed might be attributed to the increase in ionic strength of potassium in soil solution resulting a portion of K from labile pool being forced to occupy the inter latice position of expanding clay minerals (Masilamani *et al.*, 1993). The differences in K fixation in the soils were assumed to be due to the variation in soil texture, quantity and composition of clay minerals, native soil K status and K saturation of the inter lattice micaceous mineral (Patra and Debanath 1998, and Singh *et al.*, 1999).

Finally, irrespective of varying initial soil-K reserves and clay minerals, water soluble, available and fixed K consistently increased with increase in level of K application over control. The variable increase in available K in these soils upon addition of incremental doses of applied K could be due to the differences in magnitude

of initial soil K status, soil texture, the amount and composition of clay minerals (Srinivasa Rao *et al.*, 2000) and the affinity for K fixation (Patra and Debanath,1998). Maximum K fixation might be attributed to gradual saturation of K- fixing sites due to the regular application of higher doses of fertilizer K in these cultivated soils (Patel *et al.*, 1989 and Singh *et al*., 1999).

Conclusion :

In incubation studies, water soluble potassium content increased from 0 to 14 DAI and later on gradually decreased from 21 DAI to 120 DAI in fertilizer treatments. However, in control water soluble K content gradually decreased from 0 to 120 DAI but still existence of water soluble form upto 120 DAI indicates existence of dynamic equilibrium among different forms. Available K content increased in control from 0 to 14 DAI whereas in fertilized plots (from 30 to 90 kg K_2O ha^{-1}) increased upto 21 DAI, later on gradually decreased upto 120 DAI. The results clearly indicated that available K content 7 days more available in fertilized treatments than the control. Unlike water soluble and available potassium mean fixed potassium gradually increased upto 0 to 120 DAI in fertilizer treatments, whereas in control mean fixed form of K decreased gradually from 0 to 120 DAI, indicating the existence of dynamic equilibrium among themselves so that non exchangeable form content decreases and it becomes available.Regular monitoring in the change of the available and fixed –K in these soils under intensive cropping system is also imperative for meaningful K management strategy for sustainable crop production.

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REFERENCES

Chakravorty, P. and Patnaik, S. (1990). Fixation and release of potassium in flooded rice soils. *J. Indian Soc. Soil Sci.*, **38** : 243-247

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

Kanwar, J.S. and Grewal, J.S. (1966). The relationship between forms of soil potassium and particle size.*J. Indian Soc. Soil Sci.*, **14** : 221-225.

Masilamani, N., Muthian, D. and Vijalakshmi, K. (1993). Potassium fixation studies in major series of pulukottai district in Tamil Nadu. *J. Potassium Res.*, **9** : 228-232

Mortlanad, M.M. (1961). The dynamic character of potassium released and fixation. *Soil Sci.*, **91** : 11-13.

Patel, M.S., Hadwani, G.J. and Yadav, B. (1989). Fixation of potassium by clays saturation with different cations, *Soil Sci.*, **69** : 261-271.

Patra, S.K. and Debanath, N.C. (1998). Potassium fixation and releasing power of tarai acid soils of west Bengal. *J. Potassium Res.*, **15** (1-4) : 109-114.

Piper, C.S. (1966). *Soil and Plant Analysis*.Hans Publishers, Bombay

Singh, S.P., Jagat Ram, Nanak Singh and Haldar, A.K. (1999). Forms of potassium in some soils of Arunachal Pradesh. *Agropeodol*., **8** : 90-93.

Srinivasa Rao, Ch., Subba Rao, A. and Rupa, T.R. (2000).Plant mobilization of soil reserve potassium from fifteen smectitic soils in relation to soil test potassium and mineralogy. *Soil Sci*., **165**: 578-586.

Wood, L.K. and DeTurk, E.E. (1941). The absorption of potassium in soils in non replaceableforms. *Proceed. Soil Sci. Soc. America*, **5**: 152-161.