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Effect of Incubation at Different Levels of Potassium with Chloride, Sulfate, Carbonate and Nitrate Anions in Haryana Soils

R. S. KALIRAMANA AND B. S. PANNU

Department of Soil Science, CCS Haryana Agricultural University
Hisar 125004, India
E-mail : raghubir29@rediff.com

Abstract

The studies were carried out to study the effect of incubation at different level of potassium with anion i.e. chloride, sulfate, carbonate and nitrate anions in some soils of Haryana. The potassium fixation increased with the increasing days of incubation. In the five different incubation studies, the highest potassium fixation was observed in one day and the lowest was observed after 14 days of incubation at room temperature. The fixed K was highest in the Palwal soil and the lowest in Chautala soil with different levels of K. The amount of K fixed after one day was the highest followed by 2, 4, 7 and 14 days. The potassium fixation decreased with increasing days of incubation under stable conditions. The amount of fixed potassium also increased with increasing level of added K at 20 to 1000 µg/ml.
Key words : Potassium fixation, Incubation periods, Chloride, Carbonate, Nitrate anions.

Parent material and climatic condition, the two major factors of soil formation greatly influenced the K dynamics as these are also essential parameters to determine the physical and chemical functions of soil. The most important component of this dynamics is soil mineralogy, including primary and secondary minerals. The soil mineralogy depends on parent material and extent of the pedogenesis. While the degree of pedogenic processes operating in a an area is entirely a function of climate. The status of different forms of potassium in soil, their release characteristics, fixations etc. are the other important component of K dynamics which in turn are regulated by the soil mineralogical make up. It has been observed that the parent material of the alluvial soils of India are almost of similar types, derived from the Himalayan rocks by various rivers of Indo-Gangetic and Brahmaputra system during Pleistocene to recent time (1), but the soils still differ considerably in the mineralogical composition and other important soil characters, which can be seen as a direct effect of the climatic differences. Potassium is the limiting fertilizer element next to nitrogen and phosphorus in Indian soils. Research work on potassium dynamics is lacking behind because of the general impression that most of the Indian soils are well supplied with this element intensification of agriculture had led to higher removal of K from soils, which has necessitated in the progressively increasing usage of potassium fertilizer.

Methods

Twelve soils were selected from different part of the Haryana for the present investigation was typical of agricultural important soils derived from different parent material differing in their physico-chemical properties. The soil sample were collected at a fix depth of 0—25, 26—50, 51—75, 76—100 cm from all the soil profiles. The sample were dried, ground. The processed samples were analyzed for mechanical composition by using International Pipette Method electrical conductivity (EC), pH (1:2), Organic carbon, cation exchange capacity (CEC) by adopting standard processor (2). The soil samples were alkaline in reaction with the pH ranging from 7.08 to 9.25 and electrical conductivity from 0.11 to 2.62 ds/m hence soils are non-saline in nature. The most of the soils were light in texture and it ranged from sand to clay loam. The organic carbon and cation exchange capacity in these soils varied from 0.12 to 0.78 per cent and 4.62 to 36.02 c mol(p^+)/kg. The soil collected from different profiles varied widely in their textural composition. The clay, silt and sand content in these soils profiles varied from 6.68 to 35.60, 5.20 to 53.70 and 16.80 to

Table 1. Effect of incubation days on potassium fixation with different anions.

Levels of K	Cl^- Incubation period (days)					SO_4^{2-} Incubation period (days)					CO_3^{2-} Incubation period (days)					NO_3^- Incubation period (days)				
µg/ml	1	2	4	7	14	1	2	4	7	14	1	2	4	7	14	1	2	4	7	14
	µg/g					µg/g					µg/g					µg/g				
Profile-1 Chautala (Sirsa) Soil																				
20	26	33	39	42	43	16	20	23	25	26	15	19	22	24	25	12	15	18	19	21
40	36	46	53	58	59	24	31	36	39	39	22	28	32	35	36	25	32	37	41	43
80	56	72	83	91	92	37	47	55	59	61	36	45	53	57	58	24	31	36	40	42
160	72	92	107	117	110	71	91	105	115	117	68	88	102	111	112	63	80	93	101	106
200	81	102	115	129	131	76	98	114	124	126	74	95	110	120	121	73	93	108	117	123
400	138	177	205	223	223	164	210	243	265	269	153	195	227	247	250	149	191	221	241	244
600	183	235	272	297	297	218	279	324	353	356	205	262	304	332	335	198	254	294	321	324
800	232	297	345	376	381	276	353	410	446	452	260	332	386	420	423	251	321	372	406	410
1000	268	343	398	433	438	317	406	471	513	516	300	384	446	486	491	289	370	430	468	471
Profile-2 Morni (Panchkula) Soil																				
20	39	50	57	63	64	25	32	37	40	42	22	32	37	39	42	16	20	23	25	26
40	45	58	66	72	73	41	53	60	66	67	36	46	53	58	59	25	32	36	40	41
80	76	98	112	122	123	65	84	96	104	104	51	66	75	82	84	50	65	74	81	81
160	98	126	144	157	158	100	129	147	160	161	98	126	144	157	158	89	115	131	143	144
200	102	132	150	164	166	108	139	159	173	175	105	135	154	168	171	108	139	159	173	175
400	196	253	289	315	316	232	299	341	372	375	210	271	309	337	342	212	273	312	340	343
600	261	337	384	418	420	308	397	453	494	496	264	341	388	423	424	282	364	415	452	453
800	340	439	500	545	548	401	517	590	643	646	286	369	421	458	460	367	474	540	589	594
1000	406	524	597	651	654	479	618	704	767	771	414	534	609	664	666	438	565	644	702	704
Profile-3 Saha (Ambala) Soil																				
20	45	56	63	68	69	33	41	46	50	51	27	33	37	40	41	21	26	29	31	31
40	68	84	95	103	105	38	47	53	58	58	37	45	51	56	57	33	41	47	50	51
80	98	122	137	148	151	75	93	105	114	116	69	86	97	105	92	62	77	87	94	96
160	119	147	166	179	183	136	169	191	206	210	133	165	186	201	153	96	119	135	145	148
200	133	165	186	201	203	184	228	258	278	282	144	178	201	217	203	117	145	164	177	179
400	265	329	372	401	405	245	304	343	371	374	211	262	296	319	297	215	267	301	325	329
600	353	437	494	534	538	313	388	439	474	479	299	371	419	452	457	286	355	401	433	436
800	416	516	583	630	633	389	482	545	589	591	356	441	499	539	541	361	448	506	546	547
1000	596	739	835	901	906	516	640	723	781	785	505	626	708	764	768	455	564	638	689	692
Profile-4 Pipli (Kurkeshtra) Soil																				
20	61	77	95	106	110	41	52	63	71	72	40	50	62	69	70	31	39	48	54	54
40	98	124	152	170	177	54	68	83	93	94	52	66	81	91	93	35	45	55	61	61
80	102	130	158	177	184	99	126	153	172	174	100	127	155	174	176	99	126	154	172	174
160	115	146	178	200	206	109	138	169	189	194	112	142	173	194	202	102	129	158	177	184
200	132	168	205	230	234	123	156	191	213	216	143	182	221	248	249	147	186	227	254	258
400	254	323	394	441	444	234	297	363	406	408	285	362	441	494	496	275	349	425	477	479
600	338	429	524	587	589	321	408	497	557	557	379	481	587	657	657	364	463	565	632	635
800	416	528	645	722	727	405	514	628	703	707	466	592	722	809	809	449	571	696	780	784
1000	669	850	1037	1162	1169	650	826	1007	1128	1135	663	842	1027	1151	1151	639	812	991	1109	1116
Profile-5 Karnal Soil																				
20	42	50	56	61	62	30	36	40	43	44	29	35	39	43	45	23	27	30	33	35
40	58	69	77	84	89	40	47	53	57	58	39	46	52	56	57	26	31	35	38	39
80	87	104	116	126	129	81	97	108	115	118	75	89	99	108	110	74	88	98	101	103
160	158	188	211	230	236	147	175	196	209	214	143	171	191	208	208	143	171	191	186	195
200	189	225	252	275	280	159	189	212	224	231	155	184	207	225	216	152	181	203	221	223
400	356	424	474	517	524	339	403	452	477	492	322	383	429	467	472	310	369	413	451	455
600	645	768	860	903	910	464	552	619	630	650	292	347	389	408	552	425	506	566	512	520
800	740	881	986	1036	1042	571	680	761	771	799	542	645	722	758	763	523	622	697	731	750
1000	810	923	1034	1086	1092	817	931	1043	1056	1095	782	892	999	1049	964	748	853	955	902	912

Table 1. Continued.

Levels of K µg/ml	Cl^- Incubation period (days) 1	2	4	7	14	SO_4^{2-} Incubation period (days) 1	2	4	7	14	CO_3^{2-} Incubation period (days) 1	2	4	7	14	NO_3^- Incubation period (days) 1	2	4	7	14
	µg/g					µg/g					µg/g					µg/g				
Profile-6 Sonipat Soil																				
20	32	38	43	46	47	18	21	24	26	28	16	19	21	23	25	12	15	16	18	19
40	46	55	61	67	67	23	27	30	33	35	22	26	30	32	33	16	19	21	23	24
80	68	81	91	99	99	50	59	66	72	76	45	54	61	66	67	45	54	60	65	67
160	98	117	131	142	142	90	107	120	130	135	80	95	107	116	119	80	95	106	116	118
200	112	133	149	163	163	97	115	129	141	144	95	112	126	137	139	93	110	124	135	137
400	170	202	227	247	247	201	239	267	291	295	190	227	254	277	279	184	219	245	267	270
600	226	269	301	316	316	267	318	356	373	375	253	301	338	354	358	244	291	326	342	343
800	256	304	341	358	359	302	359	402	422	425	286	341	381	401	403	276	328	368	386	394
1000	301	343	384	404	407	355	405	454	476	479	336	383	429	450	452	325	371	415	436	440
Profile-7 Bhiwani Soil																				
20	26	31	35	38	40	25	30	33	36	38	27	32	35	39	40	21	25	28	30	32
40	39	46	52	57	60	32	38	43	46	49	34	40	45	49	50	22	26	29	32	33
80	66	79	88	96	102	67	80	89	97	101	67	80	89	97	97	66	79	88	96	98
160	117	139	156	170	180	111	132	148	161	166	117	140	156	170	174	109	129	145	158	159
200	128	152	171	186	197	117	139	156	170	175	124	147	165	180	182	121	144	162	176	177
400	251	299	335	365	387	243	289	324	353	357	252	300	336	366	370	242	288	322	351	355
600	334	397	445	467	486	323	384	430	452	454	333	397	444	467	471	321	382	428	449	451
800	337	401	449	472	490	365	434	486	511	521	377	448	502	527	530	363	432	484	508	518
1000	501	571	640	672	685	485	553	619	650	656	501	571	640	672	675	481	549	615	645	651
Profile-8 Narnaul Soil																				
20	23	27	31	33	38	18	21	24	26	31	19	23	26	28	29	15	18	20	22	23
40	32	38	43	46	47	24	29	32	35	39	25	30	34	37	38	20	24	26	29	30
80	45	53	59	65	66	51	61	68	74	81	50	60	67	73	75	50	59	66	72	74
160	86	102	114	125	127	92	109	123	134	138	97	115	129	141	142	88	105	118	128	131
200	97	115	129	141	142	99	118	132	144	146	105	124	139	152	153	102	122	137	149	150
400	189	225	252	275	278	197	234	263	286	287	212	252	282	308	311	204	243	272	297	300
600	248	295	330	347	349	247	294	329	346	348	277	330	370	388	390	267	318	356	374	378
800	296	352	394	414	418	257	306	343	360	362	336	400	448	471	480	319	380	426	447	499
1000	399	455	510	535	540	356	406	455	477	480	447	510	571	599	605	431	491	550	578	581
Profile-9 Satnali (Mahendragarh) Soil																				
20	23	27	31	33	34	19	23	26	28	30	19	23	25	27	29	15	18	20	21	23
40	38	45	51	55	56	29	34	38	42	44	28	33	37	41	43	19	23	26	28	30
80	49	58	65	71	72	60	71	80	87	92	55	65	73	80	85	55	65	73	79	84
160	94	112	126	137	140	109	129	145	158	167	106	126	141	154	158	92	109	122	133	141
200	106	126	141	154	159	117	140	156	170	181	114	136	152	166	176	112	133	149	163	168
400	179	213	239	261	263	212	252	282	308	326	201	239	268	292	299	194	231	258	282	293
600	239	284	318	334	335	282	335	375	394	410	267	318	356	374	389	258	307	343	361	375
800	306	364	408	428	432	361	430	481	506	526	343	408	457	480	493	331	393	441	463	471
1000	385	439	492	516	520	455	519	581	610	622	432	492	552	579	585	417	475	532	558	562
Profile-10 Sahibi River (Rewari) Soil																				
20	26	31	35	38	40	23	27	30	33	37	22	26	29	32	34	17	20	23	25	26
40	48	57	64	70	74	31	37	42	45	51	30	36	40	44	47	21	25	28	30	32
80	65	77	87	94	100	61	73	82	89	94	56	67	75	82	87	56	66	74	81	83
160	96	114	128	139	148	95	113	127	138	142	107	128	143	143	156	98	117	131	142	146
200	107	128	143	156	165	105	125	140	153	158	115	137	153	153	167	113	134	151	164	170
400	196	233	261	284	291	179	213	239	260	266	219	261	292	305	319	211	252	282	307	309
600	260	310	347	364	369	246	293	328	344	348	292	348	390	401	409	254	302	339	355	360
800	328	390	437	459	462	311	370	415	435	438	367	437	490	505	514	315	375	420	441	448
1000	408	465	521	547	549	425	485	543	570	573	457	521	584	602	613	399	455	509	535	539

Table 1. Continued.

Levels of K µg/ml	Cl^- Incubation period (days) 1	2	4	7	14	SO_4^{2-} Incubation period (days) 1	2	4	7	14	CO_3^{2-} Incubation period (days) 1	2	4	7	14	NO_3^- Incubation period (days) 1	2	4	7	14
	µg/g					µg/g					µg/g					µg/g				
Profile-11 Sohna (Guargaon) Soil																				
20	29	35	39	42	45	25	29	33	36	38	24	29	32	35	37	19	22	25	27	29
40	45	54	60	65	69	34	40	45	49	52	34	41	45	50	53	23	27	30	33	35
80	55	65	73	80	84	67	80	90	98	101	62	74	83	90	95	61	73	82	89	94
160	86	102	115	125	132	122	145	163	177	153	95	113	127	138	146	109	129	145	158	167
200	119	142	159	173	178	132	157	176	192	197	127	151	169	184	189	126	150	168	183	194
400	240	285	320	348	354	283	337	377	411	416	269	320	358	390	399	259	308	345	376	399
600	319	379	425	446	448	376	448	501	527	528	284	338	378	397	403	344	409	458	481	500
800	411	489	548	576	579	485	578	647	679	684	461	548	614	645	650	444	529	592	622	647
1000	485	553	620	651	655	573	653	731	768	773	545	622	696	731	736	524	598	669	703	717
Profile-12 Palwal Soil																				
20	59	70	79	86	91	40	48	54	58	60	39	47	52	57	60	30	35	40	43	46
40	87	104	116	126	134	51	61	68	74	76	50	59	67	73	77	44	52	59	64	68
80	129	154	172	187	199	107	128	143	156	145	99	118	132	144	148	86	102	115	125	127
160	150	179	200	218	221	195	232	260	283	230	190	226	253	276	282	98	116	130	142	145
200	179	213	239	260	266	198	236	264	288	291	193	230	258	281	288	173	206	231	252	267
400	319	380	425	463	471	376	448	502	547	549	283	337	377	411	416	345	410	459	501	507
600	391	465	521	547	553	406	483	541	568	568	286	340	381	400	406	371	442	495	520	527
800	468	557	624	655	661	519	618	692	727	727	493	587	657	690	701	475	566	634	665	672
1000	623	710	795	835	842	711	810	908	953	953	675	769	861	904	912	651	742	831	872	880

88.00% respectively. Soil samples taken from different soil profile depths (0—25, 26—50, 51—75, 76—100 cm) were ground and 10g of each sample was mixed separately with solution of potassium chloride having different concentrations i.e. 20, 40, 80, 160, 200, 400, 600, 800, 1000 µg/ml in a beaker for 72 hours at 40±2°C. After equilibration the sample was extracted with 1N NH_4OAc solution. Potassium in the extract was determined on flame photometer. The fixed K was calculated by deducting 1N NH_4OAc extracted K in potassium chloride treated soil from the sum of initial 1N NH_4OAc extracted K and applied K. Similar procedures were adopted for other anions i.e. K_2 CO_3, K_2SO_4, and KNO_3 (3). The potassium fixation capacity was calculated as follows : Potassium fixation capacity (%) = [K fixed/K applied] × 100.

Results and Discussion

Effect of Incubation at Different Levels of Potassium with Chloride Anion

The potassium fixation increased with the increasing days of incubation period. In the five different incubation studies, the low potassium fixation was observed after 14 days of incubation at room temperature. The fixed K was highest in the Palwal soil (91 to 842 µg/g) and lowest in Chautala soil (43 to 438 µg/g). When the incubation period was up to 14 days the amount of fixed K decreased maximum. The amount of K fixed after one days (55—60%) higher than that of 4 day (25—30%) and it was lowest after 14 days (6 to 8%). The potassium fixation decreased with increasing days of incubation under stable condition. The amount of fixed potassium also increased with increasing level of added K at 20 to 1000 µg/ml in Table 7. Similar results were obtained of applied potassium chloride (KCl) to three sets of soils. The first set of soil samples were extracted with one normal ammonium acetate K after one day of incubation. The second and third sets were extracted with the same extract after seven and 42 days of incubation, respectively. The amount of K fixed was determined. Correlation between applied and fixed K was carried out. While fixation increased with increase in the concentration of added K, there was no linear relationship between the proportion of K fixed and the amount added at higher incubation periods. Potassium recov-

ered also increased with added K in all the incubation periods with the 42-day period having the highest amount of K recovered. Potassium added was highly correlated with fixed K during all the incubation periods (4).

Effect of Incubation at Different Levels of Potassium with Sulfate Anion

The potassium fixation increased with the increasing days of incubation. In the five different incubation studies, the low potassium fixation was observed after 14 days of incubation at room temperature. The fixed K was highest in the Palwal soil (46 to 880 μg/g) and lowest in Chautala soil (26 to 516 μg/g). When the incubation period was up to 14 days the amount of fixed K decreased maximum. The amount of K fixed for one day (45—60%) higher than that after 4 day (25—30%) it was lowest after 14 days (5 to 6%). The potassium fixation decreased with increasing days of incubation under stable condition. The amount of fixed potassium also increased with increasing level of added K at 20 to 1000 μg/ml (Table 1). The rate of K fixation increased during initial days and continued up to 15 days (47%). Simple correlation followed by regression analysis indicated that at 45 days of incubation, K fixation was highly significant and positively correlated with most of the soils parameters like pH, silt, clay, CEC (5).

Effect of Incubation at Different Levels of Potassium with Carbonate Anion

The potassium fixation increased with the increasing days of incubation. In the five different incubation studies, the low potassium fixation was observed after 14 days of incubation at room temperature. The K fixed was highest in Palwal soil (60 to 912 μg/g) and lowest in Chautala soil (25 to 491 μg/g). When the incubation period was up to 14 days the amount of fixed K decreased maximum. The amount of K fixed after one day (45—55%) higher than that after 4 day (35—40%) and it was lowest after 14 days (4 to 5%). The potassium fixation decreased with increasing days of incubation under stable condition. The amount of fixed potassium also increased with increasing level of added K at 20 to 1000 μg/ml (Table 1). The amount of K fixed increased when the incubation extended up to 14 days, the amount of K fixed was highest in Palwal soil and lowest in Chautala soil. When the incubation period was extended upto 14 days the amount of K fixed decreased. Similar results were given by Grewal and Kumar (6) in Punjab soils, where 90% of potassium fixation took place in one day and the equilibrium was established in seven days. The difference in the rate of the potassium fixation in different soils is due to the nature of the clay minerals presents in these soils.

Effect of Incubation at Different Levels of Potassium with Nitrate Anion

The potassium fixation increased with the increasing days of incubation. In the five different incubation studies, the low potassium fixation was observed after 14 days of incubation at room temperature. The highest fixed K in Palwal soil (46 to 880 μg/g) and lowest in Chautala soil (20 to 417 μg/g). When the incubation period was up to 14 days, the amount of K fixed decreased maximum. The amount of K fixed after one day (45—50%) higher than that of after 4 day (15—25%) and it was lowest after 14 days (5—6%). The potassium fixation decreased with increasing days of incubation under stable condition. The amount of fixed potassium also increased with increasing level of added K 20 to 1000 μg/ml. When the incubation period for potassium fixation was increased upto 14 days, the highest amount of K fixation was observed in Palwal soil and lowest in Chautala soil. The fixation increased significantly upto 4 days after this period there was no spectular increase. This indicated that the equilibrium reached within seven days.

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