

Vertical Distribution of Various Forms of Potassium in Different Agroclimate Regions of Haryana

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Abstract

Vertical distribution of different forms of potassium in major soils of Haryana has been investigated. The soil samples collected from different profiles varied widely in their textural composition. The most of the soils were light in texture and it ranged from sand to clay loam. The soils were alkaline in reaction. The electrical conductivity of the soils was less than 2.61 dS/m hence the soils are non-saline in nature. The organic carbon and cation exchange capacity in these soils varied from 0.12 to 0.78% and 4.62 to 36.02 c mol (p⁺)/kg, the highest being in Palwal soil. It showed a position significant correlation with CEC, silt, and clay content and negatively correlated with pH and sand content. The highest amount of available K and total K were found in Palwal soil, whereas Chautala soil showed the lowest amount. Correlation study showed that all the forms of potassium were positively significant correlated with O.C, CEC, silt, clay content of soil and sand showed negative correlation with all forms of K except water soluble K. The different forms of potassium were positive and significant correlation among themselves. The potassium content decreased with the increase in particle size fractions.

Key words : Potassium in soils, Forms and distribution, Correlation between forms of K, Soil physico-chemical properties, Major soils of Haryana.

Potassium has presented a challenge to those who have attempted to establish its exact function in plant. Unlike N, P, S, Ca and Mg, potassium does not enter into permanent organic combinations in the plant but exists for the most part as soluble inorganic and organic salts. Plants take up potassium as the potassium ion (K⁺). Soil potassium can be categorized into four distinct form viz. solutions, exchangeable, non-exchangeable and mineral potassium. Approximately 98% is bound in the mineral and non-exchangeable form whereas only 2% is in solution and exchangeable form which are considered as the most available form of potassium for plant (1, 2). There is enough evidence that not only the solution and exchangeable potassium is used by plants, but the non-exchangeable and mineral potassium may be utilized by the growing plants. All these forms are interrelated and maintain equilibrium in the soil system. The existence of these various forms of soil potassium and its incessant transformation from one form into another and the gains and losses of this nutrient generate a dynamic system in soil which can simply be referred as potassium dynamics. It is a complex phenomenon

of processes controlling the ultimate availability of soil potassium to plants. The status of different forms of potassium in soil, their release characteristics, fixations 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, 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. A study was undertaken on distribution of various forms of potassium in major soils of Haryana.

Table 1. Location, agro-ecological sub-zones and taxonomic classification of the selected soil profiles.

Profile no.	Location	Climate	Agro ecological sub-region	Classification
1	Chautala (Sirsa)	Semi-arid	Aeolian plain, hot dry, semi-arid, insignificant available moisture less than 90 days growing period	Coarse loamy mixed, hyperthermic, Aridic, Haplustept
2	Morni (Panchkula)	Sub-humid	Siwaliks, dry to moist subhumid, moderately to large moisture availability, 180—210 days growing period	Coarse loamy, mixed, hyperthermic family of Typic Ustorthent
3	Saha (Ambala)	Semi-arid	Alluvial plain, upper terrace, dry sub-humid, moderately to large water availability, 150—180 days growing period	Fine loamy, mixed, hyperthermic family of Typic Haplustpt
4	Pipli (Kurukshetra)	Semi-arid	Indo-gangetic alluvial plain, dry sub-humid, moderately to large water availability, 150—180 days growing period	Fine loamy, mixed, hyperthermic family of Typic Haplustept
5	Karnal	Semi-arid	Yumuna alluvial plain, hot and semi-arid, moderately available moisture, 120—150 days growing period	Fine loamy, mixed, hyperthermic family of Typic Natrustalf
6	Sonipat	Semi-arid	Yumuna alluvial plain, hot and semi-arid, low to moderately available moisture, 90—120 days growing period	Coarse loamy, mixed, hyperthermic family of Typic Ustifluent
7	Bhiwani	Semi-arid	Aeo-fluvial plain, hot and semi-arid, low available moisture, 60—90 days growing period	Fine loamy, mixed, hyperthermic family of Fluventic Haplustept
8	Narnaul	Semi-arid	Rugged hilly terrain of Aravalli range, hot and semi-arid, low to moderate available moisture 90—120 days growing period	Coarse loamy, mixed, hyperthermic family of Typic Ustorthent
9	Satnali (Mahendergarh)	Semi-arid	Rugged hilly terrain of Aravali range, hot and semi-arid, low to moderate available moisture 90—120 days growing period	Sandy mixed, hyperthermic family of Typic Ustisamment
10	Sahibi River (Rewari)	Semi-arid	Aeo-fluvial alluvial plain, hot and semi-arid, low available moisture, 120—150 days growing period	Fine loamy, mixed hyperthermic family of Fluvent Haplustept
11	Sohna (Gurgaon)	Semi-arid	Hilly terrain of Aravali range, hot and semi-arid, moderate available moisture 90—120 days growing period	Sandy loam, mixed, hyperthermic family of Typic Ustisamment
12	Palwal	Semi-arid	Yumuna alluvial plain, hot and semi-arid, moderately available moisture, 90—120 days growing period	Fine loamy, mixed, hyperthermic family of Typic Haplustept

Methods

Twelve soil profiles were exposed and samples were collected depth wise from Chautala (Sirsa), Morni (Panchkula), Saha (Ambala), Pipli (Kurukshetra), Karnal, Sonipat, Bhiwani, Narnaul, Satnali (Mahendergarh), Sohna (Gurgaon), Sahibi River (Rewari) and Palwal locations in Haryana representing sub-humid and semiarid agro-ecological zones, of Haryana. Depth-wise soil samples were collected from all the selected soil profiles. Some important morphological characteristics studied in the field and described according to the Soil Survey Manual (3).

The soil samples collected from selected sites were air dried in shade, ground with wooden pestle and mortar and passed through 2 mm sieve. In the processed samples (< 2 mm), electrical conductivity (EC), pH (1 : 2), Organic carbon, Cation exchange capacity (CEC) and particles size distribution using standard processor Table 1.

Water soluble potassium was measured in a saturation extract following shaking of 5g soil samples in 20 ml water for 1 hour. Exchangeable potassium Neutral normal ammonium acetate extractable method was adopted for the estimation of exchangeable K. The actual exchangeable K was determined by sub-

Table 2. Vertical distribution of various forms of potassium, morphological and physico-chemical properties in different soils. KFC = Potassium fixation capacity.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH (1:2)	EC (ds/m)	OC (%)	CEC (cmol ⁺ /kg)	KFC (%)	Water soluble K (mg/kg)	Exchangeable K (mg/kg)	Available K (mg/kg)	Non-exchangeable K (mg/kg)	Mineral lattice K (mg/kg)	Total K (mg/kg)
Profile-1 Chautala (Sirsa) Soil														
0—25	75.3	17.8	6.9	8.01	1.18	0.59	4.82	10.22	24	73	97	475	13038	13610
26—50	69.8	22.2	8.0	8.34	0.95	0.47	4.62	10.45	21	68	89	586	12810	13480
51—75	68.2	19.2	12.6	8.56	0.80	0.39	5.89	7.15	15	75	90	592	13895	14570
76—100	64.2	20.8	15.0	8.80	0.65	0.32	6.84	5.42	10	59	69	605	15085	15700
Profile-2 Morni (Panchkula) Soil														
0—25	56.0	32.6	11.4	7.38	0.35	0.68	10.96	15.37	20	85	105	555	14990	15150
26—50	66.1	23.9	10.0	7.08	0.23	0.45	8.48	12.45	12	78	90	425	13255	13770
51—75	75.4	16.0	8.6	7.21	0.16	0.29	6.04	9.90	15	65	80	490	12390	13060
76—100	72.0	18.3	9.7	7.14	0.08	0.23	7.04	8.20	12	60	72	530	11198	11800
Profile-3 Saha (Ambala) Soil														
0—25	50.7	29.8	19.5	8.50	0.58	0.38	16.03	23.63	30	110	140	730	16700	17660
26—50	30.4	45.4	24.2	8.59	0.36	0.19	16.84	20.62	20	103	123	890	19690	20700
51—75	18.2	53.7	28.1	8.64	0.31	0.16	17.85	19.39	10	80	90	970	21150	22310
76—100	18.0	46.4	35.6	8.70	0.24	0.13	19.85	17.18	8	74	82	920	20818	21820
Profile-4 Pipli Soil (Kurukshetra)														
0—25	28.2	42.4	29.4	8.28	0.28	0.78	18.60	22.94	40	150	190	1060	21650	23900
26—50	20.3	44.3	35.4	8.18	0.22	0.52	22.47	21.38	20	140	160	1146	23825	25230
51—75	22.4	46.3	33.3	8.34	0.18	0.26	24.49	16.54	15	133	148	1156	24495	25800
76—100	16.8	52.0	32.2	8.92	0.14	0.15	20.03	15.69	10	120	130	990	22270	23390
Profile-5 Karnal Soil														
0—25	41.3	22.5	36.2	8.28	2.61	0.47	20.42	27.90	20	90	110	730	17090	17930
26—50	37.3	23.3	29.4	8.49	1.58	0.34	24.42	28.42	15	96	111	890	17700	18700
51—75	42.2	25.0	32.8	8.58	1.20	0.23	18.47	21.93	10	91	101	930	19850	20880
76—100	50.8	30.2	28.0	8.92	0.98	0.12	16.04	19.51	5	63	68	815	18007	18890
Profile-6 Sonipat Soil														
0—25	75.0	12.2	12.8	8.79	0.95	0.42	8.29	12.14	10	60	70	530	15000	15600
26—50	78.2	11.0	10.8	9.36	0.80	0.29	7.20	9.78	10	55	65	570	13735	14370
51—75	75.2	12.5	12.3	9.33	0.67	0.21	6.78	8.18	5	45	50	590	12400	13040
76—100	70.6	15.5	13.9	9.25	0.45	0.18	5.72	8.96	5	35	40	540	11900	12410
Profile-7 Bhiwani Soil														
0—25	48.5	31.1	20.4	8.21	1.06	0.42	13.34	18.04	32	105	137	907	20666	21780
26—50	44.8	37.3	17.9	8.01	0.61	0.39	9.18	16.46	28	121	149	1120	22270	23540
51—75	41.7	39.3	19.0	7.86	0.31	0.27	14.86	12.05	24	102	126	1005	20430	21560
76—100	38.3	40.5	21.2	7.59	0.20	0.24	18.48	10.64	21	80	101	920	17890	18910

Table 2. Continued.

Depth (cm)	Sand (%)	Silt (%)	Clay (%)	pH (1:2)	EC (ds/m)	OC (%)	CEC (cmol ⁺ /kg)	KFC (%)	Water soluble K (mg/kg)	Exchangeable K (mg/kg)	Available K (mg/kg)	Non-exchangeable K (mg/kg)	Mineral lattice K (mg/kg)	Total K (mg/kg)
Profile-8 Narnaul Soil														
0—25	82.3	7.3	10.4	7.81	0.45	0.42	7.25	16.10	15	60	75	472	14090	14640
26—50	84.9	10.5	8.6	7.67	0.35	0.27	5.26	17.02	20	75	95	428	13427	13950
51—75	86.0	13.8	9.2	7.92	0.27	0.18	5.42	9.49	25	65	90	370	12010	12470
76—100	82.0	8.4	9.6	8.14	0.11	0.33	6.04	8.13	10	55	65	403	11942	12310
Profile-9 Satnali (Maherdragarh) Soil														
0—25	88.0	4.6	7.4	7.25	0.30	0.22	4.69	15.55	42	55	97	425	12810	13380
26—50	86.8	5.2	8.0	7.49	0.21	0.17	5.52	13.95	20	65	85	438	12188	12730
51—75	84.0	6.3	9.7	7.84	0.16	0.13	6.08	12.59	12	60	72	432	11986	12490
76—100	82.0	7.0	11.0	7.61	0.14	0.14	6.81	11.63	10	45	55	428	11307	12890
Profile-10 Sahibi River Soil (Rewari)														
0—25	78.2	9.0	12.8	7.69	0.44	0.27	8.17	16.46	34	68	102	478	14055	14635
26—50	79.1	10.3	10.6	7.57	0.33	0.21	6.60	15.43	28	60	88	502	14330	14920
51—75	80.2	8.4	11.4	7.43	0.24	0.15	7.13	15.02	22	54	76	476	12953	13505
76—100	79.0	8.0	13.0	7.78	0.21	0.18	8.52	14.87	18	44	62	445	12488	12995
Profile-11 Sohna (Gurgoan) Soil														
0—25	68.2	22.8	9.0	7.52	0.34	0.69	4.45	19.57	20	85	105	790	19285	20180
26—50	70.3	22.2	7.5	7.68	0.25	0.36	5.04	18.24	15	80	95	830	21135	22060
51—75	64.0	24.0	12.0	7.84	0.15	0.24	6.73	16.86	15	65	80	860	20420	21360
76—100	59.2	26.8	14.0	8.12	0.06	0.15	7.60	15.68	10	60	70	830	18390	19290
Profile-12 Palwal Soil														
0—25	40.2	29.3	29.5	8.20	0.88	0.48	18.75	24.29	20	162	182	890	24293	25370
26—50	38.3	32.2	25.5	8.43	0.92	0.34	15.17	25.30	15	153	168	899	25888	27055
51—75	36.4	36.4	28.2	8.67	0.83	0.27	16.89	22.42	10	144	154	986	22240	23380
76—100	34.2	40.2	35.6	8.75	0.68	0.22	19.91	19.11	5	132	137	1042	24580	25760

tracting the value of water soluble K from the NH₄OAc extractable K. Non-exchangeable potassium was determined as per the procedure of Knudsen et al. 4. The NH₄OAc extracted K was then subtracted from the HNO₃ extracted K to calculate the amount of non-exchangeable potassium in soil. Mineral potassium was calculated as the difference between the total and HNO₃ extractable potassium. Total potassium was determined by following digestion of soil with 48% HF and 72% HClO₄ solution in platinum crucible at 200- 225 C on a sand bath. The content

was dissolved by adding 5 ml of 6N HCl and boiled on a hot plate (5). The amount of K in each of the above extracts was determined with the help of Elico digital flame photometer.

Results and Discussion

Water Soluble Potassium in Soils

The water soluble potassium of these soils

Table 3. Correlation between different forms of K, soil properties and potassium fixation capacity. *Significant at 5% ($r = .29$), **significant at 1% level of significance ($r = .35$), $n = 48$.

Soil properties/ Forms of K	PH	EC	CEC	OC	Sand	Silt	Clay	KFC
WS-K	-0.452**	-0.008	-0.080	0.396**	-0.007	0.043	-0.053	0.209
Exchangeable-K	0.114	0.127	0.694**	0.445**	-0.713**	0.661**	0.662**	0.629**
Now-exchangeable-K	0.312*	0.092	0.812**	0.356**	-0.838**	0.810**	0.724**	0.558**
Mineral K	0.252	0.076	0.797**	0.378**	-0.798**	0.727**	0.761**	0.643**
Total K	0.268	0.075	0.805**	0.413**	-0.805**	0.732**	0.771**	0.638**

ranged between 5 to 42 mg/kg Table 2. This form of K accounts for about 0.06% of the total potassium in these soils. The surface horizon of all soils except Sonipat had higher amount of water soluble K and it decreased with increase in depth. The water soluble potassium status of sub humid region soils was in lower range as compared to the semi to arid soils. This may due to the high rate of leaching loss showing to the high rainfall condition. The amount of water soluble potassium was low in these soils. This form of K account for about 0.06 per cent of the total potassium in these soils. The surface horizon of all soils except Sonipat have highest amount of water soluble K then it decreased with the increase in depth. This type of behavior may be due to the fact that organic matter is capable of blocking specific and non-specific K binding sites resulting in reduced amount of K fixation. Therefore, a sufficient amount of K remains in water soluble forms (6). Correlation study of different forms of K with soil properties showed that

water soluble potassium was significantly and positively correlation with EC ($r = -.008$), CEC ($r = 0. -0.08$), organic carbon ($r = 0.396**$), silt ($r = 0.043$), and clay ($r = -0.053$), content whereas negatively correlated with pH ($r = -0.452**$), and sand ($r = -0.007$). There is no significant relationship between the water soluble K and physico-chemical properties of soil in Table 3. However it was positive and significantly correlated with exchangeable K and thereby indicated the existence of equilibrium between two most available forms of K in terms of plant uptake. Water soluble K data was correlated with different fractions of K and observed (Table 4) that it was positively significant correlated with exchangeable potassium ($r = 0.386**$). The better correlation of these forms of potassium with other forms indicate that the water soluble potassium was governed by the other forms of potassium like non-exchangeable and total potassium. Similar results were also reported by Bhasker et al. (7).

Table 4. Correlation between different forms of K. *Significant at 5% ($r = .29$), **significant at 1% level of significance ($r = .35$), $n = 48$.

Forms of K	Water soluble-K	Exchangeable-K	Non-exchangeable-K	Mineral K	Total K
Water soluble-K	1.000				
Exchangeable-K	0.386*	1.000			
Non-exchangeable-K	-0.032	0.757**	1.000		
Mineral K	-0.016	0.826**	0.944**	1.000	
Total K	-0.022	0.824**	0.950**	0.997**	1.000

Table 5. Correlation between different forms of K. *Significant at 5% ($r = .29$), **significant at 1% level of significance ($r = .35$), $n = 48$.

Forms of K	Water soluble-K	Exchangeable-K	Non-exchangeable-K	Mineral K	Total K
Water soluble-K	1.000				
Exchangeable-K	0.386*	1.000			
Non-exchangeable-K	-0.032	0.757**	1.000		
Mineral K	-0.016	0.826**	0.944**	1.000	
Total K	-0.022	0.824**	0.950**	0.997**	1.000

Exchangeable Potassium

Exchangeable potassium varied from of 35 mg/kg in the lower horizon of Sonipat soil to a of 162 mg/kg in the surface horizon of Palwal soil. Exchangeable K also showed a decreasing trend with depth in most of the soil profiles. Some soils such as Bhiwani, Narnaul, Karnal and Chautala sub-surface to surface horizon contained higher amount of exchangeable K than the surface horizon and thereafter it showed a decreasing trend with depth. Exchangeable potassium was found minimum in Sonipat soil and maximum in Palwal soil. Exchangeable K also showed a decreasing trend with depth in most of the soil profiles. The possible reason for higher content of exchangeable K in surface soil may be the same as stated with respect to water soluble K. In some soils such as Bhiwani, Narnaul, Karnal and Chautala sub-surface horizon contained higher amount of exchangeable K than the surface horizon and thereafter it showed a decreasing trend with depth. This irregular distribution pattern was also observed by Dinakaran et al. (8). There may be three possible reasons, fineness of the texture, the illuviation process and lastly the diversified source of alluvium containing varying amount of inherent potassium, which are responsible for the irregular distribution of exchangeable K with depth. Similar to the water soluble K, the exchangeable K content was also low in the sub-humid region soil compared to semi-arid regions due to high rate of leaching loss and dominance of kaolinite which poses low cation exchange capacity. The very high amount of exchangeable K in Palwal and Pipli soils may be due to high content of clay and silt in the these soils. The value of correlation coefficient of exchangeable K with soil properties showed that exchangeable K was significant and positively correlated with EC ($r = 0.127$) CEC ($r = 0.127$) CEC ($r = 0.694^{**}$), organic carbon ($r = 0.445^{**}$), KFC ($r = 0.629^{**}$), silt ($r = 0.661^{**}$) and clay ($r = 0.662^{**}$) content whereas negatively correlated with sand ($r = -0.713^{**}$) (Table 4). The potassium fixation capacity also was found positive significantly correlated with CEC (0.44^*), exchangeable K (0.32^*), non-exchangeable K (0.31^*) content of soil as supported by Venkatesh and Satyanarayana (1999). The available K representing the sum of water soluble and exchangeable K as these two forms are most readily

taken up by the plant. The relationship between the various soil properties and forms of potassium with available K is closely related to the exchangeable form of soil potassium.

Non-Exchangeable Potassium

The range of non-exchangeable potassium content was between 370 to 1156 mg/kg in these soils. It constituted 3—9% of the total soil potassium. There was no specific trend of non-exchangeable K distribution was observed with soil depth. Which might be due to active pedoturbation processes operating in these soils, but was very much related to the soil texture as the value increased with the fineness of the texture, these results are in agreement with that of Bhaskar et al. (7). The non-exchangeable K correlation with soil properties showed (Table 3) that it was significant and positively correlated with CEC ($r = 0.812^{**}$), organic carbon ($r = 0.356^{**}$), KFC ($r = 0.558^{**}$), silt ($r = 0.810^{**}$), and clay ($r = 0.724$), whereas negatively correlated with pH ($r = 0.312^*$), and sand ($r = -0.838^{**}$).

The non-exchangeable K was also found to be positive and significantly correlated to water soluble K, exchangeable K, mineral K and total K indicate that some K^+ adsorbed on the edges of inner site of lattice, which could not be replaced with NH_4^+ might have been extracted with $IN HNO_3$ (9). The relationship with total K ($r = 0.950^{**}$) reflected that primary K bearing minerals are the main source of potassium in soil which released some amount of K to this pool. Secondly its relationship with exchangeable K ($r = 0.757^{**}$) showed that both forms are in dynamic equilibrium, once exchangeable K depleted, K from non-exchangeable pool will be released to maintain the concentration of former one. The pH showed significant negative correlation with water soluble, exchangeable and non-exchangeable K in saline sodic soils.

Mineral or Lattice Potassium

The mineral K content of these soils varied from 11,198 mg/kg in Satnali soil to 25888 mg/kg in Palwal

soil. There was no consistent trend in its distribution in all the selected soil profiles. In case of subsurface layer it was maximum in Palwal soil (25,888 mg/kg). The lowest value of total potassium in different layers was recorded for the Satnali which had lowest content (11,198 mg/kg). There was no definite trend in its distribution in all the selected soil profiles. Mineral K data was correlated with different fractions of K and observed that it was positive and significantly correlated with water soluble potassium ($r = 0.386^{**}$), exchangeable potassium ($r = 0.757^{**}$), non-exchangeable potassium ($r = 0.944^{**}$) and total potassium ($r = 0.977^{**}$) in Table 4 and it was significant and positively correlated with coarse and medium sand indicating the presence of bulk of K bearing mica primary mineral in those fractions by Ahmed and Walia (10).

Total Potassium

The total K content of these soils varied from 11800 mg/kg in Satnali soils to 27055 mg/kg in Palwal Table 2. There was no consistent trend in its distribution in all the selected soil profiles. In case of surface layer it was maximum in Palwal soil (27,055 mg/kg) which was followed by Pipli, Bhiwani, Saha, Karnal, Morni, Chautala, Narnaul, Sohna, Sonipat, Sahibi river, Satnali soils. The lowest value of total potassium in was recorded in Satnali soil (11,800 mg/kg) which had lowest clay content and highest in Palwal soil which had the maximum clay content. The total K content was observed lowest in Santali soil and highest in Palwal soil. No specific trend was observed in the total K in all the selected soils. In case of subsurface layer it was maximum in Palwal soil (27,055 mg/kg) followed by Pipli, Sohna, Bhiwani, Saha, Morni, Karnal, Cautala, Narnaul, Sonipat, Sahibi river and Satnali soils. The lowest value of total potassium was recorded in Satnali soil and highest in Palwal soil which had the maximum clay content. The lowest value of total K may be due to the effect of potassium depletion by the crops from the surface soil. The results are in agreement with the finding of Singh et al. (6). The total K was positively correlated with exchangeable K (0.62^{**}) and non-exchangeable (0.84^{**}) which indicated and existence of dynamic equilibrium in between these two forms of soil potassium. This relationship also suggested that the avail-

ability of K in these soils could be determined to some extent by total K.

The total K was significant and positively correlated with CEC ($r = 0.805^{**}$), organic carbon ($r = 0.413^{**}$), silt ($r = 0.732^{**}$), and clay ($r = 0.771^{**}$), whereas, negatively correlated with pH ($r = -0.268^{**}$), and sand ($r = -0.805^{**}$) (Table 3). These relationships confirmed that the finer fractions of the soils are in primary sources of potassium in soils of Haryana. The results also point out that the light textured soils would be depleted easily than heavy textured for native potassium. Therefore, continue monitoring of soil potassium status is essential on these types of soil. Dinagaran et al. (8) also observed positive correlation between total K and CEC, organic carbon, KFC, silt and clay content. The inter relationship of these forms indicated that the availability of K in such soils would be in the long run and can be determined by total K. Mineral K in this study is defined as the difference between the total K and boiling HNO_3 extracted potassium. It varied from 1.07 to 1.42 per cent where the lowest and highest values were shown by the same horizon as in the case of total K. It contributed approximately 93% of total potassium and showed an identical relationship with various physico-chemical properties and different forms of potassium as with total K. Its relationship with the different K bearing minerals was also similar to the relationship of total K with these minerals. Total K showed a positive and significant correlation with other forms i.e. water soluble K ($r = 0.386^{**}$), exchangeable K ($r = 0.824^{**}$), and Non-exchangeable K ($r = 0.950^{**}$) (Table 5).

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