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SOIL CHEMISTRY

Potential Buffer Capacity of Soils with Respect to Potassium (by the Example of the Amur River Region)

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Abstract—Thermodynamic parameters of potassium adsorption have been determined in the main soil types of the Amur River region. Potential buffer capacity with respect to potassium and the content of available potassium in a given soil type depend on the soil texture and the degree of soil cultivation. Extensive and thermodynamic parameters of the potassium status of soils are shown to be closely interrelated.

INTRODUCTION

According to modern concepts, soil is an open stationary thermodynamic system. The values of its thermodynamic functions are constants, and exchange reactions proceed in agreement with chemical equilibria. The laws of chemical thermodynamics make it possible to predict numerous aspects of the chemical status of soil, including its change under anthropogenic impacts [8, 13]. Potassium is present in soil in exchangeable forms and its release from the solid soil phase into the soil solution depends on the energy of exchange reactions. Therefore, to optimize the potassium regime of soils, both extensive and thermodynamic parameters of the behavior of potassium should be taken into account.

Potassium potential (PP) is one of the characteristics of the potassium status of soils; it characterizes the intensity of potassium release from the solid soil phase into the soil solution and the reverse reaction independently from the particular forms of potassium compounds [3, 13]. Initially, energies of these reactions (PP values) were determined by Woodruff [23]; later, somewhat different PP scales for separate types of soils were determined by Russian scientists on the basis of long-term experiments [3, 12, 17].

However, to assess the conditions of potassium uptake by plants, one should know not only the intensive parameters (PP values) but also the extensive parameters, i.e., the contents of potassium and calcium in soils. These two factors characterize two aspects of ion status in soils. They can be interrelated by the notion of potential buffer capacity of soils with respect to potassium (PBC^K). The PBC^K characterizes soil capacity to resist changes in the content of available potassium under the impact of natural and anthropogenic factors and to maintain the balance (typical of particular soil) between ion activities of potassium and alkaline-earth elements in the soil solution in the course of ion-exchange reactions [19]. The PBC^K is related to sorption–desorption processes acting in the soil. The range of its values is divided into very low (<20), low (20–50), medium (50–100), elevated (100–200), and high (> 200).

Isotherms of PBC^K make it possible to estimate the properties of soil exchange complex on the basis of the energy of bonds between exchangeable cations and the soil solid phase, because they are determined at a constant ionic strength of the solution. The shape of these isotherms depends on the mineralogical composition of fine-dispersed soil fractions [16].

There are two types of adsorption positions in the soil adsorption complex (SAC). First, these are positions with relatively low and even energy of bonds that are believed to be associated with exchangeable cations on nonspecific positions on outer crystal surfaces (*p*-positions). Second, these are positions with a higher but uneven energy of bonds (*e*-positions) that might occur on the edges, bends, and projected parts of crystal surfaces, i.e., on specific exchange positions [14]. Potassium adsorbed on *p*-positions is considered to be available for plants ($-\Delta K0$). Potassium adsorbed on *e*-positions is less available for plants ($-KX$). Taken together, these two parameters characterize the total pool of labile potassium in particular soils ($-KL$).

The analysis of PBC^K curves shows that soils with equal ratios of ion activities (at which soil adsorbs or desorbs equal amounts of potassium, AR0) can release different amounts of available potassium into the solution; these amounts depend on the mineralogical composition of particular soils. They are governed by (i) the content of exchangeable and nonexchangeable potassium in soil, (ii) the amount of fine-dispersed fractions (mainly, the clay fraction), and (iii) the properties of the outer surface of soil particles participating in ion-exchange reactions [7, 12, 17, 19–21]. Within a given genetic soil type, the PBC^K depends on the soil texture [18].

The higher the PBC$^{\text{K}}$, the more stable the equilibrium between potassium in the soil solid phase and the soil solution and, hence, the more stable the soil fertility. However, a rise in the PBC$^{\text{K}}$ is not always favorable because, under conditions of severe potassium depletion, it attests to the mobilization of slightly available potassium compounds, which causes a decrease in soil fertility [1, 5, 8]. The value of PBC$^{\text{K}}$ may also vary throughout the growing season and after application of fertilizers and lime [2, 9, 11]. Analyzing the deviation of PBC$^{\text{K}}$ values from those typical of a given soil, one can judge the trend of changes in the soil fertility.

The necessity of studying thermodynamic parameters of the potassium status of particular soil types in particular regions is beyond question. However, at present, these parameters are only known for some soils in the Central Russian Upland and Western Siberia [2, 7, 12, 15]. Potassium buffering has not been studied in soils of the Far Eastern zone of brown forest soils, though the need in these data (along with data on the content of available potassium) is evident. This work is aimed at filling this gap. The potential buffer capacity of soils with respect to potassium and the factors controlling have been determined in the most widespread soil types of the Amur River region.

OBJECTS AND METHODS

The main soil types of the central Amur, Arkhar–Bureya, and Zeya–Bureya plains have been studied. Depending on the particular elements of topography, they are differentiated into brown forest, bleached brown forest, meadow-brown, bleached meadow-brown, chernozem-like meadow-brown, and meadow gley soils (according to [6]). Data on the content and distribution of different forms of potassium in these soils have been published in [4]. Potential buffer capacity of soils with respect to potassium was determined according to the Beckett method [14]. Particle-size distribution data were obtained by the pipette method with pyrophosphate treatment. The values of the potassium potential of soils were appreciated according to the scale developed by Woodruff [23].

RESULTS AND DISCUSSION

Isotherms of PBC$^{\text{K}}$ in brown forest soils depend on the soil texture and its mineralogical composition (Fig. 1). The lowest inclination is typical of the curves obtained for relatively coarse-textured horizons transitional to the soil-forming rock (BC horizons) characterized by the minimum PBC$^{\text{K}}$. The steepest curves are obtained for heavy-textured soil horizons in the middle part of the profile (Table 1). Surface layers are usually characterized by medium and high PBC$^{\text{K}}$; in deep horizons, PBC$^{\text{K}}$ is low and even very low. In general, PBC$^{\text{K}}$ values in most of the studied soil pits are close to optimum values; their highest values are observed for soil horizons in the middle part of the profile.

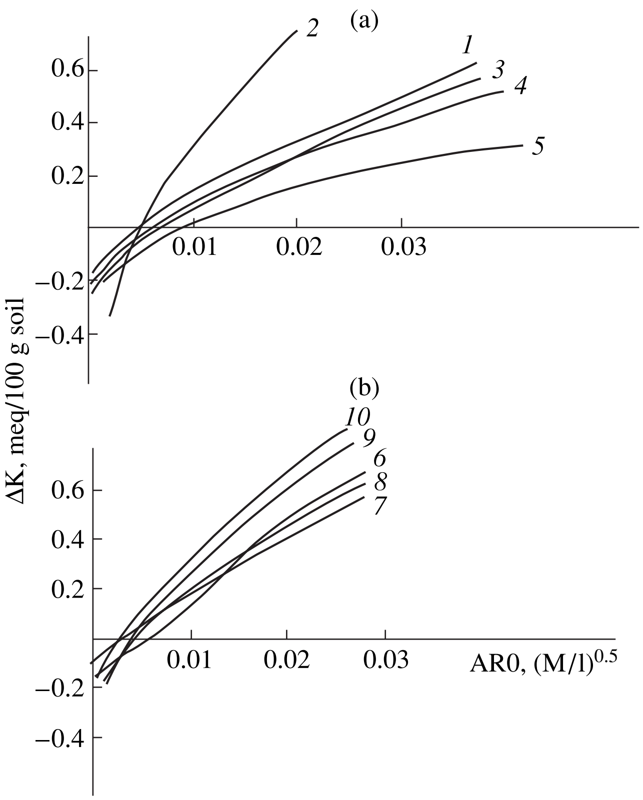

Fig. 1. Isotherms of PBC$^{\text{K}}$ for (a) brown forest and (b) bleached meadow-brown soils; soil horizons: (*1*) A1, (*2*) AB, (*3*) B1, (*4*) B2, (*5*) BC, (*6*) Asod, (*7*) A2g, (*8*) B1g, (*9*) B2g, and (*10*) BCg.

The contents of easily exchangeable and labile potassium (–ΔK0 and –KL, respectively) are high in the topsoil horizon and decrease sharply in deeper horizons. Minimum values of potassium adsorbed on *e*-positions (–KX) are also typical of the BC horizon containing a considerable amount of coarse particles of slightly weathered mica. In the humus horizon, the amount of potassium adsorbed on specific positions is also high and sometimes exceeds 50% of KL, probably, because of the weathered character of mineral surfaces under conditions of percolative water regime and oxidative medium (Eh is from 510 to 740 mV), as well as because of biogenic potassium uptake in this horizon [4].

Differences in PBC$^{\text{K}}$ within a given soil type are related to soil texture: brown forest medium loamy soils are characterized by a higher buffer capacity and potassium potential than brown forest light loamy soils. Among the soils of similar texture, PBC$^{\text{K}}$ and the contents of mobile and labile potassium are somewhat higher for virgin soils.

It should be mentioned that the relationship between PBC$^{\text{K}}$ values and the content of physical

Table 1. Potential buffer capacity with respect to potassium and the content of physical clay and clay in brown forest and bleached meadow-brown soils

Horizon	Depth, cm	PBC^K	$AR_0 \times 10^{-3}$ M/l$^{0.5}$	$-\Delta K_0$	$-KL$	$-KX$	PP	Fraction content, %	
				meq/100 g soil				<0.001 mm	<0.01 mm
Shallow brown forest soil on alluvial deposits, pit 136									
A1	0–10	56.6	5.12	0.29	0.63	0.34	2.29	10	23
AB	10–22	60.9	4.12	0.25	0.29	0.04	2.38	16	30
B1	22–38	35.2	5.12	0.18	0.24	0.06	2.29	12	38
B2	38–60	29.6	5.40	0.16	0.22	0.06	2.26	10	37
BC	60–87	19.7	7.09	0.14	0.15	0.01	2.15	5	24
Brown forest soil on coarse sand, pit 56									
Ap	0–20	47.2	6.23	0.29	0.52	0.23	2.21	7	24
B1	20–37	68.5	5.45	0.37	0.41	0.04	2.26	6	18
B2	37–64	62.9	5.41	0.34	0.40	0.06	2.27	9	18
BC	64–80	25.5	5.93	0.15	0.17	0.02	2.23	1	6
Shallow brown forest soil on alluvial deposits, pit 19									
A1	0–9	79.2	5.45	0.43	0.57	0.14	2.26	19	32
AB	9–19	124.3	4.14	0.51	0.66	0.15	2.38	24	40
B1	19–33	78.1	4.94	0.39	0.46	0.07	2.30	22	39
B2	33–58	46.3	5.82	0.27	0.28	0.01	2.23	24	37
BC	58–76	27.3	6.23	0.17	0.18	0.01	2.21	19	29
Brown forest soil on coarse sand, pit 15									
Ap	0–22	75.8	5.09	0.31	0.44	0.13	2.29	16	30
ÄÇ	22–40	102.6	4.12	0.42	0.49	0.07	2.38	22	38
B1	40–63	64.3	4.15	0.28	0.34	0.06	2.38	10	32
B2	63–93	36.6	4.64	0.17	0.24	0.07	2.33	6	22
BC	93–130	30.9	5.93	0.18	0.21	0.03	2.23	10	23
Bleached meadow-brown soil on light clay, pit 4									
Asod	0–10	74.8	6.23	0.47	0.58	0.11	2.21	14	40
A2g	10–18	67.4	4.04	0.27	0.45	0.18	2.39	35	44
B1g	18–55	67.0	4.14	0.28	0.46	0.18	2.38	28	57
B2g	55–90	112.0	4.03	0.45	0.58	0.13	2.39	30	59
BCg	90–150	128.8	3.27	0.42	0.55	0.13	2.49	29	59
Bleached meadow-brown soil on light clay, pit 20									
Asod	0–25	89.2	3.81	0.34	0.49	0.15	2.42	15	45
A2g	25–33	82.0	3.47	0.29	0.38	0.09	2.46	33	46
B1g	33–66	146.9	3.45	0.51	0.69	0.18	2.46	27	68
B2g	66–93	119.1	3.67	0.44	0.64	0.20	2.44	29	56

clay (<0.01 mm) and clay (<0.001 mm) in brown forest soils is relatively weak. It may be supposed that PBC^K values in these soils are also affected by other factors (for example, by differences in soil mineralogy).

Bleached meadow-brown soils are characterized by three types of sorption isotherms (Fig. 1). Linear correlation between the content of easily exchangeable potassium (–K) and AR is seen in bleached horizons and characterizes potassium adsorption on nonspecific exchange positions of hydromica and kaolinite. Illuvial horizons are characterized by typical adsorption isotherms, whose curvilinear part describes potassium adsorption on specific potassium-selective positions and is related to the presence of montmorillonite in the clay fraction. In the soddy horizons, potassium adsorption isotherms are S-shaped. According to Sokolova and Kuibysheva [16], this type of adsorption isotherms attests to the presence of two types of nonspecific exchange positions related to montmorillonite and vermiculite (or montmorillonite with different charges) in the studied samples.

The largest part of adsorption isotherms (especially in illuvial horizons) lies above the X-axis, which means that the soils tend to adsorb potassium from the solution rather than to desorb it. Increased values of PBC^K are typical of deep gleyed horizons; medium values are observed in surface horizons (Table 1).

The humus horizon of cultivated bleached meadow-brown soils is characterized by a lower content of easily exchangeable and labile potassium. The PBC^K is optimum only in the soddy horizon (with the minimum content of tightly adsorbed potassium and maximum AR$_0$); in the other horizons, the values of potassium potential are considerably higher.

Isotherms of PBC^K in cultivated bleached brown soils have all characteristic features typical of this type of soil formation (Fig. 2). The minimum inclination of the curve and the lowest PBC^K are typical of eluvial horizons, and the steepest curves are seen in illuvial horizons with maximum PBC^K values. Virtually in all studied soil pits, adsorption curves in the humus and bleached horizons are S-shaped. Deeper in the profile, the shape of isotherm curves becomes typical.

Values of PBC^K in the surface layers are medium and vary slightly (except for pit 8) (Table 2). In illuvial horizons, they are usually higher and more variable than in the topsoil. Bleached horizons in these soils have the most stable thermodynamic system, as they have the lowest intensity of ion adsorption [10]. Values of –ΔK0 and –KL are relatively high and display an eluvial–illuvial distribution in the soil profile. The value of –KX is also relatively high because of the heavy soil texture. Distribution of AR0 throughout the profile is uneven, with a slight tendency to its increase in deep horizons. Potassium potential varies considerably; potassium supply of plants is extremely unfavorable in pits 8 and 13, unfavorable in pit 6, and satisfactory in the other soil pits. The maximum potassium potential is typical of bleached horizons, and the highest portion of easily exchangeable potassium is in the exchange complex of illuvial horizons.

Meadow-brown soils are characterized by low PBC^K values in top horizons, rather high PBC^K values in illuvial horizons, and high PBC^K values in deep soil layers (Table 2). The content of labile potassium is maximum in the soddy horizon and minimum in the A1 and AB horizons; values of –KX in these layers are the highest (70% of –KL), while in the rest part of the profile they do not exceed 42%. Potassium potential is favorable only in the soddy horizon.

Chernozem-like meadow-brown soils are characterized by the highest PBC^K values among all studied soils (Table 3). Sorption isotherms are steep (Fig. 2). Values of PBC^K are high throughout the soil profile with a maximum in the middle part and a minimum in the surface horizon. On the contrary, the highest values of AR0 are seen in the humus horizon with a smaller slope of adsorption isotherms. The potassium content is high throughout the soil profile.

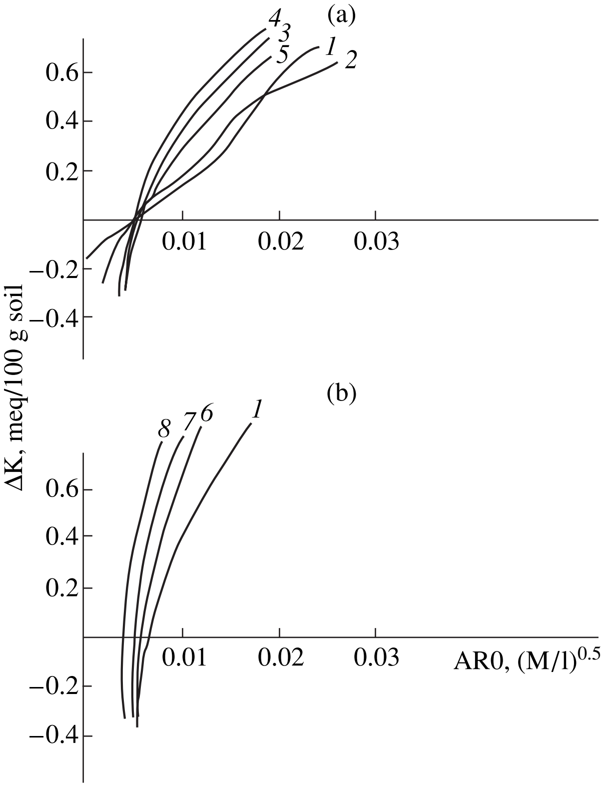

Fig. 2. Isotherms of PBC^K for (a) bleached brown and (b) chernozem-like meadow-brown soils; soil horizons: (*1*) Ap, (*2*) A2, (*3*) B1, (*4*) B2g, (*5*) BCg, (*6*) B1, (*7*) B2, and (*8*) B3.

In heavy-textured soils, a high potassium potential in the humus horizon together with a high content of labile potassium attest to favorable conditions of potassium supply of plants [17]. Judging from the values of potassium potential and KX, in the middle part of the profile of chernozem-like meadow-brown soils, potassium ions are more firmly adsorbed in the exchange complex; this might be due to the predominance of smectites in the clay fraction.

The values of PBC^K in meadow gley soils are moderately high in virgin soils and high in cultivated soils; they increase down the soil profiles and then drop to some extent in the gley horizon (Table 3). In soils on sandy clays, PBC^K values are considerably lower than in soils on fluviolacustrine clays. The distribution of AR0 values in the soil profile is opposite to that of the PBC^K: it is somewhat higher in the G horizon than in the soil horizons. The content of labile potassium is very high with a maximum in deep horizons and a minimum in the eluvial horizon. This is probably caused by the minimum content of smectites in the latter horizon.

Table 2. Potential buffer capacity with respect to potassium and the content of physical clay and clay in bleached brown and meadow-brown soils

Horizon	Depth, cm	PBC^K	$AR_0 \times 10^{-3}$ M/l$^{0.5}$	$-\Delta K_0$	$-KL$	$-KX$	PP	Fraction content, %	
				meq/100 g soil				<0.001 mm	<0.01 mm
Bleached brown soil on colluvial clay, pit 8									
A1	0–22	99.9	2.42	0.24	0.45	0.21	2.61	25	45
A2	22–38	70.7	2.77	0.20	0.39	0.19	2.56	35	48
B1g	38–68	94.7	5.45	0.52	0.64	0.12	2.26	35	61
B2g	68–96	136.4	4.42	0.60	0.80	0.20	2.35	39	66
Bleached brown soil on colluvial clay, pit 13									
Ap	0–20	143.2	1.77	0.26	0.37	0.11	2.75	22	46
A2	20–43	96.2	1.48	0.14	0.31	0.27	2.83	30	51
B1g	43–65	145.8	3.06	0.45	0.53	0.08	2.51	27	58
B2g	65–95	148.5	2.99	0.44	0.69	0.25	2.52	26	64
Bleached brown soil on sandy clay, pit 6									
Ap	0–22	98.7	3.85	0.27	0.56	0.39	2.41	23	42
A2	22–42	85.1	3.76	0.32	0.39	0.07	2.42	30	59
B1g	42–65	132.3	5.12	0.68	0.76	0.08	2.29	36	59
B2g	65–90	114.5	4.42	0.51	0.69	0.18	2.35	36	59
Bleached brown soil on sandy clay, pit 27									
Ap	0–20	94.0	4.78	0.45	0.60	0.15	2.32	20	51
A2	20–40	83.8	3.96	0.33	0.50	0.17	2.40	27	54
B1g	40–54	103.2	4.46	0.46	0.65	0.19	2.35	35	58
B2g	54–82	104.0	4.61	0.48	0.67	0.19	2.33	36	66
BCg	82–110	98.1	4.71	0.46	0.69	0.23	2.33	25	57
Bleached brown soil on sandy clay, pit 28									
Ap	0–20	83.5	4.52	0.38	0.66	0.28	2.34	19	56
A2	20–35	82.3	4.55	0.37	0.49	0.12	2.34	16	58
B1g	35–55	107.8	5.10	0.55	0.69	0.14	2.29	23	60
B2g	55–72	126.2	5.10	0.65	0.81	0.16	2.29	31	61
BCg	72–95	85.3	6.36	0.54	0.78	0.24	2.20	31	57
Meadow-brown soil on sandy clay, pit 15									
Asod	0–15	42.0	9.79	0.41	0.53	0.12	2.00	20	32
A1	15–28	31.3	2.79	0.09	0.28	0.19	2.55	23	47
ÄB	28–48	25.2	4.38	0.11	0.29	0.18	2.35	25	47
B1	48–70	94.6	2.44	0.23	0.40	0.17	2.61	30	51
B2g	70–80	129.3	2.53	0.33	0.52	0.19	2.60	30	53

The values of potassium potential point to optimum conditions of plant nutrition only in virgin soils (throughout the profile) and in the plow horizon of pit 11 (according to the scale given in [17]). A considerable rise in PBC^K values and a drop in $-\Delta K0$ values in combination with a rise in potassium potential in plowed soils in comparison with virgin soils attest to the beginning of potassium depletion in plowed soils.

Analysis of correlation between characteristics of potassium status determined by conventional methods [4] and thermodynamic parameters of humus and illuvial horizons of the investigated soils has shown that the relationship between them is well pronounced (all correlation coefficients are significant at probability level of no less than 90%) (Table 4). A direct correlation between PBC^K, $-\Delta K0$, KL, and the contents of exchangeable and nonexchangeable potassium has been revealed. Soil texture exerts a considerable effect on PBC^K and $-KL$ values. This concerns mainly the

Table 3. Potential buffer capacity with respect to potassium and the content of physical clay and clay in chernozem-like meadow-brown and meadow gley soils

Horizon	Depth, cm	PBC^K	$AR_0 \times 10^{-3}$ M/l$^{0.5}$	$-\Delta K_0$	$-KL$	$-KX$	PP	Fraction content, %	
				meq/100 g soil				<0.001 mm	<0.01 mm
Meadow-brown chernozem-like soil on sandy clay, pit 21									
Ap	0–22	133.9	4.55	0.61	0.75	0.14	2.34	25	52
AB	22–34	139.0	3.59	0.50	0.62	0.12	2.44	27	58
B1	34–57	194.5	2.89	0.56	0.92	0.36	2.54	36	59
B2	57–74	180.9	3.07	0.56	0.85	0.29	2.51	30	59
B3	74–88	151.3	3.50	0.53	0.67	0.14	2.46	30	57
BC	88–109	137.1	3.92	0.52	0.65	0.13	2.40	25	53
Chernozem-like meadow-brown light clay soil on clayey colluvium, pit 23									
Ap	0–24	140.5	5.02	0.71	0.90	0.19	2.30	27	53
AB	24–47	149.9	2.95	0.44	0.68	0.24	2.53	29	54
B1	47–67	163.0	2.85	0.46	0.66	0.20	2.55	34	56
B2	67–100	175.1	2.80	0.49	0.67	0.18	2.55	30	47
B3	100–124	155.0	3.70	0.57	0.68	0.11	2.43	26	53
BC	124–170	170.5	3.53	0.60	0.76	0.16	2.45	28	55
Meadow gley soil on fluviolacustrine sandy clay, pit 3									
Ä1	0–21	71.0	7.18	0.51	0.86	0.35	2.14	27	50
G	21–42	70.3	7.80	0.55	0.75	0.20	2.11	35	55
B1g	42–60	67.8	9.07	0.62	0.85	0.23	2.05	38	58
B2g	62–87	69.4	7.78	0.54	0.89	0.35	2.11	46	68
BCg	87–160	72.0	5.43	0.39	0.87	0.48	2.26	46	66
Meadow gley soil with concretions on fluviolacustrine clay, pit 5									
Ap	0–22	105.9	3.54	0.38	0.82	0.44	2.45	27	53
G	22–46	98.2	3.92	0.39	0.88	0.49	2.41	37	60
B1g	46–75	139.4	3.12	0.43	0.83	0.40	2.51	35	62
B2g	75–105	162.6	3.56	0.58	0.89	0.31	2.45	37	64
BCg	105–150	226.8	3.87	0.88	1.21	0.33	2.41	50	75
Meadow gley soil with concretions on fluviolacustrine clay, pit 11									
Ap	0–20	104.7	4.34	0.45	0.88	0.43	2.36	29	53
G	20–45	102.9	3.38	0.35	0.88	0.53	2.47	33	55
B1g	45–80	110.3	4.42	0.49	0.90	0.41	2.35	37	67
B2g	80–120	176.2	4.04	0.67	1.16	0.49	2.39	42	70
BCg	120–150	182.2	4.71	0.86	1.21	0.35	2.33	53	73

content of physical clay fraction, because silt particles are the main source of easily available potassium [22].

A close correlation between –KL, the content of nonexchangeable potassium, and the content of physical clay (<0.01 mm) fraction makes it possible to suppose that potassium ions fixed on ion-exchange positions with high energy of bonds can become available for plants under certain conditions. Soil texture also affects the values of PBC^K and the potassium potential.

Illuvial horizons are characterized by the inverse dependence between the total potassium and the PBC^K or –KL. As the total amount of potassium is determined by its content in primary minerals, negative correlation coefficients point to the fact that the PBC^K and the amount of labile potassium depend primarily on the content of secondary clay minerals as the main source of ion-exchange positions. This correlation is stronger in illuvial horizons than in surface layers, which is

Table 4. Coefficients of correlation between parameters of potassium status and potential buffer capacity of soils with respect to potassium in different soil horizons

Parameters of potassium status	PBC^K	$-\Delta K_0$	KL	PP
Humus horizon				
Clay content, %	0.73	–	–	0.45
Physical clay content, %	0.74	–	0.43	0.46
Exchangeable potassium, mg/100 g	–	0.77	0.82	–
Nonexchangeable potassium, mg/100 g	0.59	0.77	0.63	–
Illuvial horizon				
Clay content, %	0.58	–	0.56	0.50
Physical clay content, %	0.57	–	0.63	–
Exchangeable potassium, mg/100 g	0.68	0.64	0.64	–
Nonexchangeable potassium, mg/100 g	0.75	0.50	0.60	0.44
Total potassium, %	−0.44	–	−0.53	–

explained by more stable soil-forming conditions deep in the soil profile (the absence of variations in Eh, moisture content, and temperature; smaller effect of chemical ameliorants; and other factors).

CONCLUSIONS

(1) Chernozem-like meadow-brown soils are characterized by the best potassium status among soils of the Far East region of brown forest soils. A high content of labile potassium in combination with high PBC^K values and optimum potassium potential permit ensure a high and stable fertility level of these soils for a long time. The regulation of unfavorable water–air regime in these soils is the only measure necessary to obtain sustainable high yields.

(2) Low PBC^K and high AR0 values in brown forest soils in combination with a medium content of labile potassium and coarse soil texture attest to favorable conditions of potassium supply of plants. At the same time, these soils are easily subjected to potassium depletion. Thus, application of potassium fertilizers is necessary to support the fertility of these soils under conditions of their agricultural use.

(3) A rise in PBC^K values and potassium potential and a drop in –ΔK0 in the humus horizon of cultivated bleached meadow-brown and brown soils, as well as meadow gley soils, in comparison with their virgin analogues attest to the beginning of potassium depletion.

(4) In all the soils (except for brown forest soils), PBC^K values increase downward the soil profile. The highest values of –ΔK0 and –KL are typical of heavy-textured chernozem-like meadow-brown and meadow gley soils; the lowest content of available potassium is seen in bleached brown soils. Minimum –KX values are typical of coarse-textured soils; the values of –KX in heavy-textured soils depend on mineralogical composition of their clay fraction.

(5) The values of potassium potential attest to good conditions of potassium supply of plants in brown forest and chernozem-like meadow-brown soils and in virgin horizons of meadow-brown, bleached meadow-brown, and meadow gley soils. Unfavorable conditions are formed in cultivated bleached meadow-brown bleached brown forest soils.

(6) Extensive and thermodynamic parameters of the potassium status of soils should be used in combination while studying the potassium regime of soils.

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