

FIXATION OF POTASSIUM IN FINNISH SOILS

ARMI KAILA

University of Helsinki, Department of Agricultural Chemistry

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On the basis of a material, collected from various parts of the world, SCHUFFELEN and van der MAREL (13) claim that the glacial soils of Finland and Norway have a high capacity to fix potassium. In the Swedish soils the fixation of potassium is also reported to be marked (4, 9, 17). According to van der MAREL (7), the ability of the glacial soils of arctic regions to fix potassium may be attributed to their feldspars and micas which have lost potassium superficially by weathering. In some Norwegian studies, a high fixation capacity was found to be connected with the occurrence of vermiculite in the clay fraction (14, 18). The Swedish scientists assume that mica-lattices poor in potassium (4), or illites (9) are the essential factors in the fixation.

In Finland very little has been published on the fixation of potassium. KERÄNEN (5) found in a laboratory experiment that alternative wetting and drying resulted in a considerable fixation of potassium by two acid clay soil samples; fixation was promoted by liming and by increasing the concentration of exchangeable potassium. In a previous paper on the fixation of ammonium in our soils (2), the writer also reported some data on the fixation of potassium. This seemed to be of the same order as in the German soils analyzed by SCHACHTSCHABEL and KÖSTER (12) with the same method. The correlation between the fixation of potassium and the fixation of ammonium in the samples studied was fairly close, the total linear correlation coefficient being $r = 0.83^{***}$.

SCHUFFELEN and van der MAREL (13) drew their conclusion, mentioned above, on the basis of only four subsoil samples of Finnish glacial varved clay with the pH values from 6.6 to 7.8. In these samples the fixation of potassium by their wet method ranged from 17 to 62 per cent and by their dry method from 78 to 85 per cent of 100 mg K_2O applied per 100 g of soil.

In the present paper an attempt is made to get a more representative picture about the fixation of potassium in Finnish soils, both in samples of surface soils and in those of deeper layers. The relation of this phenomenon to the soil texture, pH and content of organic matter is studied by statistical methods.

Methods

The fixation of potassium is generally determined as the amount of added potassium not extractable by an ammonium salt solution. It is doubtful, whether this kind of procedure would actually give the quantity of added potassium which is no more in exchange equilibrium with the soil solution. The results will largely depend on the conditions under which the treatment is performed, e.g. on the period of contact, temperature, concentration of the potassium salt solution applied, and particularly on drying. In any case, there are no possibilities to get any absolute value for this fixation, and results obtained by any conventional method will be comparable only with analyses carried out by the same method.

In the present work the fixation of potassium was determined without drying the suspension of soil in the potassium chloride solution, and the results are likely to be markedly lower than those which may be obtained by a »dry method», even in soils not containing montmorillonite. The procedure adopted by SCHACHTSCHABEL (11) was used:

10 g soil was shaken in 25 ml of 0.01 N KCl for one hour. 25 ml of neutral N ammonium acetate was added, and the suspension was shaken for an other hour. Potassium in the filtrate was determined with an EEL-flame photometer. The amount of added potassium fixed against the extraction with ammonium acetate was calculated on the basis of results obtained when an other sample of 10 g was in the same way extracted for one hour with 50 ml of 0.5 N neutral ammonium acetate.

Soil pH was measured in 1:2.5 suspension in 0.01 M CaCl₂ by the glass electrode. Organic carbon was estimated by the procedure of WALKLEY (15), using the iodometric titration.

According to the results of the mechanical analysis, the soil samples were grouped into the textural classes used in Finland (cf. 3).

Material

265 samples of mineral soils were collected from various parts of the country, both from the plough layer, or the corresponding layer in the virgin soils, and from the deeper layers between the depths of 20 cm and 70 cm, in some cases even down to 260 cm or 310 cm. The samples were air-dried and ground.

The 135 surface samples and the 130 subsoil samples were distributed in the various textural classes as reported in Table 1. About one half of the samples from the surface layer are clay soils, while about two thirds of the subsoil samples contain more than 30 per cent of the fractions finer than 2 μ . Particularly the samples of heavy clay with more than 60 per cent of these fractions, are mainly found in the deeper layers both in the present material and in nature. It is also of interest to note that the average content of the finest material, less than 0.6 μ , is significantly higher in the subsoil samples of the heavy clay than in the samples of the surface soils. In 11 samples of heavy clay this fraction is at least 70 per cent, the highest values are 85 and 86 per cent. The total clay content in these samples is more than 90 per cent.

It may be necessary to mention that the textural groups of heavy clay and silty clay do not contain only typical varved glacial soils, but also several samples

Table 1. Soil samples

	Number of samples	pH*	Org. C %*	Particle size fractions, %*			
				< 0.6 μ	0.6-2 μ	2-6 μ	6-20 μ
<i>Surface samples</i>							
Finesand	19	5.5 \pm 0.2	2.7 \pm 0.4	7 \pm 3	5 \pm 1	7 \pm 2	13 \pm 3
Loam	31	5.2 \pm 0.2	3.5 \pm 0.6	11 \pm 2	11 \pm 1	15 \pm 1	19 \pm 2
Silt	19	5.2 \pm 0.2	3.1 \pm 0.7	6 \pm 1	13 \pm 2	28 \pm 1	31 \pm 3
Sandy clay	9	5.5 \pm 0.6	3.4 \pm 1.2	31 \pm 5	12 \pm 2	8 \pm 1	8 \pm 2
Clay loam	21	5.2 \pm 0.2	3.8 \pm 0.6	24 \pm 4	14 \pm 1	14 \pm 2	16 \pm 2
Silty clay	27	5.2 \pm 0.2	4.0 \pm 0.6	26 \pm 3	17 \pm 2	21 \pm 3	16 \pm 1
Heavy clay	9	5.3 \pm 0.3	4.4 \pm 1.9	43 \pm 7	21 \pm 4	14 \pm 3	8 \pm 2
<i>Subsoil samples</i>							
Finesand	10	5.5 \pm 0.4	0.5 \pm 0.2	6 \pm 4	4 \pm 2	5 \pm 2	14 \pm 6
Loam	15	5.2 \pm 0.2	0.8 \pm 0.2	11 \pm 3	12 \pm 3	17 \pm 3	25 \pm 3
Silt	17	5.6 \pm 0.4	0.4 \pm 0.4	7 \pm 2	14 \pm 3	28 \pm 4	36 \pm 6
Sandy clay	3	5.7 \pm 4.5	1.0 \pm 2.0	35 \pm 25	14 \pm 5	8 \pm 4	10 \pm 4
Clay loam	15	5.2 \pm 0.6	0.9 \pm 1.4	29 \pm 5	12 \pm 1	13 \pm 2	15 \pm 3
Silty clay	30	5.5 \pm 0.3	0.6 \pm 0.2	27 \pm 4	20 \pm 2	27 \pm 4	17 \pm 2
Heavy clay	40	6.0 \pm 0.3	0.5 \pm 0.1	57 \pm 5	19 \pm 2	11 \pm 2	7 \pm 1

* Means with the confidence limits at the 95 per cent level

in these groups are representatives of the postglacial marine sediments, the so called Litorina clays, as could be confirmed by the remnants of the marine diatoms in these samples.

The difference in the origin of the soils explains the fact that e.g. in the samples of heavy clay the pH values range from 3.6 to 7.4, and in the groups of silty clay from 3.3 to 6.8. The lower limit is found in samples of typical Litorina soils, and pH values higher than 7 only occur in some calcareous soils rare in Finland. In the other soil groups, the variation in the acidity is large, but the average values do not significantly differ from each other.

The content of organic carbon in the surface soils is fairly high, and some tendency towards an increasing amount of carbon with an increase in the clay content may be found. The relatively high content of organic matter in the subsoil samples of Litorina soils is noteworthy, and the surprisingly high average values in the groups of sandy clay and clay loam are due to one sample of Litorina soil in the former and four samples of this kind of soil in the latter group.

Results

In the present analyses, 2.5 me K was added to 100 g of soil. The ratio of soil to the potassium chloride solution was 1 to 2.5 and the period of contact was one hour. The amounts of added potassium fixed against the extraction with N ammonium acetate in the different soil groups are reported in Table 2.

Table 2. Fixation of potassium

Soil	K fixed			
	me/100 g soil		% of applied K*	me/100 g clay*
	mean*	range		
<i>Surface samples</i>				
Finesand	0.25 ± 0.04	0.09—0.38	10 ± 2	2.21 ± 0.61
Loam	0.30 ± 0.04	0.12—0.69	12 ± 2	1.40 ± 0.27
Silt	0.38 ± 0.07	0.14—0.77	15 ± 3	2.04 ± 0.35
Sandy clay	0.46 ± 0.15	0.21—0.86	18 ± 6	1.10 ± 0.30
Clay loam	0.44 ± 0.12	0.20—1.27	18 ± 5	1.15 ± 0.25
Silty clay	0.43 ± 0.06	0.17—0.85	17 ± 4	1.00 ± 0.12
Heavy clay	0.56 ± 0.03	0.39—0.68	22 ± 1	1.09 ± 0.47
<i>Subsoil samples</i>				
Finesand	0.33 ± 0.24	0.06—1.22	13 ± 10	3.73 ± 1.15
Loam	0.38 ± 0.13	0.12—0.86	15 ± 5	1.69 ± 0.43
Silt	0.50 ± 0.12	0.16—0.89	20 ± 5	2.87 ± 0.94
Sandy clay	0.54 ± 0.21	0—1.31	22 ± 8	1.00 ± 2.77
Clay loam	0.63 ± 0.27	0.13—1.80	25 ± 11	1.57 ± 0.64
Silty clay	0.97 ± 0.21	0.26—1.80	39 ± 8	2.21 ± 0.52
Heavy clay	1.04 ± 0.15	0.24—1.76	42 ± 6	1.41 ± 0.20

* Mean with the confidence limit at the 95 per cent level

Under the experimental conditions used, even the mineral soils of a coarser texture have been able to fix potassium to an appreciable degree. The high average value in the group of finesand soils of the deeper layers is due to one calcareous sample with the fixation as high as 1.22 me K per 100 g soil; without this sample the average would be 0.24 ± 0.06 me K/100 g, and the range from 0.06 to 0.37 me K/100 g soil.

Both in the surface samples and in the subsoil samples, the mean values for the fixation tend to increase from the group of the finesand soils to that of heavy clay, but mostly the variation within a group is so large that their limits are overlapping. The highest fixation may be found in the subsoil groups of silty clay and heavy clay; both of them contain 6 samples in which the fixation was more than 1.5 me K/100 g soil, and in the former group there were 15 samples and in the latter group 24 samples with a fixation higher than 1 me K/100 g. Four samples of clay loam from the deeper layers and one surface sample surpass this limit.

In all the textural groups the fixation tends to be higher in the subsoil samples than in the surface samples, but the difference in the mean values is significant only in the groups of silty clay and heavy clay.

The fixation of potassium expressed as a percentage of the 2.5 me of K applied per 100 g of soil ranges from 0 to 72 per cent. On the average, it is less than 20 per cent in all the other surface soil groups except that of the heavy clay, and in the subsoil samples it exceeds this value only in the clay soils.

The results in Table 2 are also calculated per 100 g of the clay fraction in the samples. This may not be quite justifiable, since it is possible that some minerals in the silt fraction are also taking part in the fixation (cf. 1, 6, 11). It is quite likely that this has happened also in some of the samples analyzed, since the fixation of potassium expressed in this way was even higher than 5 me K per 100 g of clay in four samples of finesand soils and two samples of silt soils. Therefore, too much significance must not be attached to these figures. Usually, they tend to be somewhat higher in the subsoil samples than in the corresponding group of the surface samples.

In the first place, the capacity of a soil to fix potassium will depend on its content of certain minerals able to trap this ion in a nonexchangeable form. The fixation of potassium may be decreased by the presence of ammonium and hydrogen ions which are able to compete with the potassium ion for the interlayer exchange positions, owing to their similar radius (16). Certain kind of organic matter and aluminium or iron hydroxides are reported to prevent the fixation by blocking the entrance between the sheets of clay minerals (8, 10). It is also likely that in soils rich in potassium, the fixation will not be significant. Thus, it could be expected that in soils with a similar mineral composition in the clay fraction, the capacity to fix potassium would increase with increasing clay content and decreasing content of organic matter, and decrease with an increase in acidity or in the content of potassium.

It is likely that the mineral composition of the clay fraction in the present material is not equal, and therefore, the extent of the fixation of potassium in these soils may not be closely connected with the contents of clay, organic matter and potassium, or with the acidity. Yet, some statistical analyses were carried out, and first of all the total linear correlation coefficients between the amounts of potassium fixed and the fractions of clay and silt, and the content of organic carbon, pH and the «exchangeable» K were calculated. The «exchangeable» K refers

Table 3. Total linear correlation coefficients between the amounts of potassium fixed and some soil characteristics

	Surface soils	Subsoils	All	Clay soils	Finesand, loam and silt soils
Number of samples	135	130	265	154	111
r between K fixed and					
pH	0.16	0.36***	0.36***	0.37***	0.43***
Org. C, %	0.09	-0.41***	-0.41***	-0.51***	-0.23*
Clay % < 0.6 μ	0.51***	0.45***	0.52***	0.36***	0.09
— » — 0.6—2 μ	0.37***	0.37***	0.38***	0.19*	0.35***
Silt %, 2—6 μ	0.04	0.09	0.10	0.11	0.26**
— » — 6—20 μ	-0.12	-0.59***	-0.45***	-0.22**	-0.59***
«Exchangeable» K	0.06	-0.06	-0.07	-0.03	-0.21*

to the amounts of potassium extracted from the untreated sample with N ammonium acetate in connection with the determination of the fixation. These results are recorded in Table 3.

In the surface soils a statistically significant correlation is found only between the fixed potassium and the fractions of finer and coarser clay, the former coefficient appearing to be somewhat higher than the latter one. Correlation coefficients of the same order between these variables may also be found for the group of the subsoil samples and for the whole material. For the clay soils the corresponding correlations are markedly lower, and in the group of the samples of a coarser texture the content of the finer clay appears to have no connection with the fixation. In this group also the content of organic matter appears to be only slightly correlated with the fixation as compared with the corresponding connection in the clay soils, and even in the group of the subsoil samples and the whole material. In these four groups the positive correlation of fixed potassium to pH is statistically significant but rather low. The negative correlation which could be expected to exist between the fixation and the content of «exchangeable» K appears to be negligible, or very low. It is of interest to find that in the group of finesand, loam and silt soils some positive connection may occur between the fixation and the content of the finer silt fraction. The relatively high negative correlation coefficients between the fixation and the fraction of the coarser silt is likely to arise from the close negative correlation between the contents of the finer fractions and the coarser fractions.

In order to get a more reliable picture about the actual dependence between the variables, further statistical treatment of the material was carried out. It was found that the low correlation between the fixation and the fraction of finer silt in the group of the finesand, loam and silt soils disappeared when the effect of the fraction of the coarser clay is eliminated. Thus, the statistical analyses cannot prove the possible role of this fraction in the potassium fixation of some of the samples.

Table 4. Coefficients of determination, r^2 , and multiple determination, R^2 , for the relationship of the amount of potassium fixed (1) with the fractions of finer clay (2) and coarser clay (3), the content of organic carbon (4), and pH (5)

	All samples	Surface soils	Subsoils	Clay soils	Finesand, loam sand silt soils
r^2_{12}	0.27	0.26	0.20	0.13	0.01
$R^2_{1.23}$	0.33	0.30	0.28	0.20	0.18
$R^2_{1.234}$	0.43	0.31	0.46	0.34	0.26
$R^2_{1.2345}$	0.46	0.35	0.46	0.36	0.49

The statistical data in Table 4 show that the part of the variation in the amount of potassium fixed under the experimental conditions which can be explained on the basis of the variation in the fraction of the finer clay is not marked, only 27

per cent in the whole material, and less than it in the various groups. Adding the variable 3, the content of coarser clay, increases the variance in the fixation which may be explained: this is most marked in the group of the finesand, loam and silt soils. Taking in account the content of organic carbon has almost no effect in the group of the surface samples but increases the variance which can be explained in the other groups, particularly in the subsoil and clay samples: in the former it explains 25 per cent and in the latter almost 18 per cent of the variance left unexplained by the contents of finer and coarser clay. When also the pH is considered, it is found that its effect is important, particularly in the group of the soils of the coarser texture in which it increases the part of the variation in the fixation which may be explained by these variables up to 49 per cent. For the subsoil samples and for the whole material the result is somewhat lower, 46 per cent, and in the

Table 5. Fixation of potassium by samples from various depths

	Depth cm	pH	Org.C %	Particle size fractions, %				K fixed me./100 g	
				< 0.6 μ	0.6-2 μ	2-6 μ	6-20 μ	soil	clay
H 1	0-10	5.5	2.5	30	15	8	11	0.35	0.8
	20-30	5.7	0.5	46	13	6	16	1.31	2.2
	40-50	6.0	0.2	45	14	9	11	1.80	3.0
	60-70	6.2	0.2	44	16	13	12	1.76	2.9
H 5	0-10	6.2	1.9	54	18	8	8	0.67	0.9
	20-30	6.1	0.7	73	14	5	3	1.17	1.3
	40-50	6.3	0.3	85	9	2	2	1.24	1.3
	60-70	6.4	0.3	86	10	2	2	1.17	1.2
L 1	0-20	5.3	5.5	18	14	19	10	0.34	1.1
	45-60	5.7	0.6	46	24	10	7	1.11	1.6
	95-105	6.3	0.3	16	24	32	22	1.75	4.4
To 1	5-15	4.7	1.4	2	9	22	39	0.31	2.8
	20-30	6.2	0.5	12	28	35	22	0.55	1.4
	40-50	6.4	0.4	2	16	32	40	0.75	4.2
	60-70	6.5	0.2	2	19	34	38	0.65	3.1
	200-210	6.7	0.1	2	23	43	30	0.62	2.5
Ot 1	10-20	5.3	0.5	18	17	26	8	1.10	3.1
	50-60	5.3	0.2	28	24	42	2	1.47	2.8
	100-120	5.8	0.2	22	26	40	11	1.80	3.8
	200-210	6.2	0.3	24	21	46	7	1.40	3.1
	300-310	6.3	0.1	20	16	38	24	1.26	3.5
J 1	10-20	5.6	0.5	68	14	9	6	0.86	1.0
	50-60	5.8	0.2	70	10	11	7	1.15	1.4
	100-110	6.1	0.1	64	16	10	6	1.36	1.7
	200-210	6.0	0.1	68	14	10	7	1.46	1.8
	250-260	6.3	0.1	34	28	28	8	1.51	2.4

groups of the clay soils and the surface samples only 35 to 36 per cent of the variation in the fixation appears to be associated with these four variables.

In the present material, the average amount of potassium fixed by the 135 samples of surface soils is 0.38 ± 0.03 me K/100 g, and by the 130 samples of subsoils 0.77 ± 0.09 me K/100 g. In the individual cases too, the fixation in the surface layer was usually significantly lower than even in the second layer. Some examples of the variation of the fixation of potassium within the same soil profile are recorded in Table 5. The samples H 1, H 5, and L 1 are from arable land, and the three other series of samples are from clay pits. It is of interest to note that in the soils H 1 and H 5, both from the same field, large differences in the fixation exist: in the surface layer, the lower fixation by sample H 1 may be attributed to its lower content of clay and higher acidity, perhaps also to its somewhat higher content of organic carbon, but in the layers from 40 to 50 cm and from 60 to 70 cm, the markedly higher content of finer clay in the soil H 5, or its higher pH have not been sufficient to warrant a higher fixation than in the soil H 1. The deepest layer analysed in the soil L 1 is considerably poorer in finer clay than the middle layer; yet, the fixation in the deepest layer is markedly higher than in the other ones. This amount of potassium fixed corresponds to 4.4 me K per 100 g of clay, and an almost equal value is found in the silt soil To 1 for the layer from 40 to 50 cm. The maximum value for the fixation of potassium in the present material was found in the silty clay sample from the depth 100 to 120 cm of the soil Ot 1, it is 1.80 me K/100 g soil. In the heavy clay soil J 1, the results are markedly lower in spite of its far higher content of the finer clay. Even within this soil, the fixation does not seem to be related to the clay content.

Discussion

Is the fixation of potassium in Finnish soils high or low? In the present material the samples of surface layers fixed, on the average, about 15 per cent, and the subsoil samples about 30 per cent of the 2.5 me or 97.5 mg of potassium added per 100 g of soil. This amount roughly corresponds to 2000 kg K/ha in a layer of 20 cm, and thus far exceeds the rate of the applications in the practice. It is likely that the relative fixation would be higher, if less potassium were added. On the other hand, the thorough mixing of the soil with the potassium chloride solution will allow of more intensive fixation than in the field.

In the present treatment the period of contact between the soil and the potassium salt solution is short, only one hour. Even though the fixation is known to be relatively rapid, it is likely that under these experimental conditions the fixation takes place mainly on the surface and edges of the particles and the penetration of the ions to the interior is less marked. It was found in incubation experiments with some of the samples that in three months about three times as much added potassium was fixed as in the present procedure. It is true in this case the incubated samples were air dried at room temperature before the exchangeable potassium was determined, and drying is known to increase the fixation. Yet, under the

natural conditions the surface soil may occasionally get rather dry, and since the effect of drying was eliminated in the method used, it is probable that these results tend to be lower than under otherwise similar conditions in the practice.

The comparison of these results with those reported in the literature does not help much, because in most works different methods have been employed. The data reported by SCHACHTSCHABEL (11, 12) on German soils analysed by the same method prove that the fixation in our soils is of the same order.

In any case, it was found that the fixation under the conditions used is not limited only to the ordinary clay soils, but also soils of a coarser texture, even some finesand soils are able to fix a not insignificant amount of added potassium. On the basis of the present results, it is not possible to find out to what extent this fixation may be due to the silt fractions. SCHACHTSCHABEL (11) estimates that the part played by the fractions $> 2 \mu$ will not be more than 10 per cent of the total fixation by the soil. MACLEAN and BRYDON (6) found that the fixation of potassium by the fine silt fraction, from 2 to 5 μ , was appreciable and in some soils even higher than that of the clay fraction; the fraction from 5 to 20 μ , too, was able to fix fairly marked amounts of potassium, and even the coarse material, from 20 to 2000 μ was not quite devoid of this capacity.

A large variation in the fixation of added potassium is typical of the soils analyzed. Somewhat less than one half of this variation may be explained on the basis of the variation in the contents of finer and coarser clay, and organic carbon, and in the acidity. The other half of the variation is probably mainly connected with the variation in the mineralogical composition of the soils, the rate of weathering and of depletion of potassium. In addition, other factors such as e.g. the amount of fixed ammonium in the soils, and the occurrence of aluminium and iron hydroxyde between the lattice sheets may play some role.

There are in Finland no reports according to which the fixation of potassium had in the practice proved to be reducing the effect of potassium fertilizers. This needs not mean that fixation of potassium would not occur under the practical conditions. It may be taken to show that, usually, the equilibrium between the fixed potassium, exchangeable potassium, and potassium in soil solution makes it possible for the plants to take up the amounts of potassium needed, even if at the time of the application of the fertilizers the fixation would dominate. Actually, the fixation of potassium may be a beneficial process in certain soils.

S u m m a r y

The fixation of potassium in Finnish soils was studied on the basis of a material consisting of 265 samples from various parts of the country. A »wet method» was employed in which 2.5 me K was added per 100 g soil, and the fixation against the extraction with neutral N ammonium acetate was determined after a period of contact of one hour.

The average fixation in the 135 samples of surface soils was 0.38 ± 0.03 me K/100 g soil, and in the 130 subsoil samples 0.77 ± 0.09 me/100 g soil, or about

15 and 30 per cent of the added potassium, respectively. In the groups of the surface samples the mean values increased with the increasing content of clay from 0.25 ± 0.04 me K/100 g soil in the finesand soils to 0.56 ± 0.03 me K/100 g soil in the samples of heavy clay containing at least 60 per cent of the fraction $< 2 \mu$. In the groups of the subsoil samples the corresponding mean values were 0.33 ± 0.24 and 1.04 ± 0.15 me K/100 g soil. In the surface soils the results ranged from 0.09 me K/100 g in a finesand soil to 1.27 me K/100 g in a clay loam, and in the subsoil samples from 0 in a sandy clay soil to 1.80 me K/100 g in one sample of clay loam and one sample of silty clay.

The fixation was positively correlated with the contents of finer clay $< 0.6 \mu$ ($r = 0.52^{***}$), coarser clay, $0.6 - 2 \mu$ ($r = 0.38^{***}$), pH ($r = 0.36^{***}$) and negatively correlated with the content of organic carbon ($r = -0.41^{***}$). These four variables explained 46 per cent of the variation in the fixation of potassium. Statistical analyses performed on the various groups showed that pH appeared to be particularly important in the group of finesand, silt and loam soils, while the content of organic carbon seemed to be noteworthy both in the clay soils and in the soils of the coarser texture.

Further studies are needed to show whether the fairly high fixation in some soils of a coarser texture may be partly attributed to the fractions of silt.

The factors influencing the fixation of potassium are discussed.

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SELOSTUS:

KALIUMIN PIDÄTTYMISESTÄ MAISSAMME VAIKEASTI VAIHTUVAKSI

ARMI KAILA

Yliopiston maanviljelyskemian laitos, Pihlajamäki

Maittemme kykyä pidättää lisättyä kaliumia vaikeasti vaihtuvaan muotoon tutkittiin 265 maanäytteen aineistoa käyttäen määrittämällä, paljonko lisätystä kaliumista (2.5 me K/100 g maata) sitoutui ammoniumasetaattiin uuttumattomaksi tunnin käsittelyn aikana ilman kuivatusta.

Keskimääräinen pidättyminen oli 135 pintanäytteessä 0.38 ± 0.03 ja 130 syvempien kerrosten näytteessä 0.77 ± 0.09 me K/100 g, eli noin 15 ja 30 % lisätystä kaliumista. Eri maalajien keskimääräinen pidätys lisääntyi saveksen pitoisuuden lisääntyessä hiedan arvosta 0.25 ± 0.04 me/100 g aitosaven arvoon 0.56 ± 0.03 me/100 g pintanäytteissä, vastaavien arvojen ollessa syvempien kerrosten näytteissä 0.33 ± 0.24 ja 1.04 ± 0.15 me/100 g. Vaihtelurajat olivat pintamaissa 0.09—1.27 me/100 g ja syvempien kerrosten näytteissä 0—1.80 me/100 g.

Pidätys oli positiivisesti korreloitunut hienon saveksen pitoisuuden ($r = 0.52^{***}$), karkean saveksen pitoisuuden ($r = 0.38^{***}$) ja pH:n ($r = 0.36^{***}$) kanssa sekä negatiivisesti orgaanisen hiilen pitoisuuden kanssa ($r = -0.41^{***}$). Nämä neljä muuttujaa selittivät 46 % kaliumin pidätyksen vaihtelusta.

Lisätutkimukset ovat tarpeen osoittamaan, missä määrin karkeammat fraktiot, ennen kaikkea hiesu, osallistuvat kaliumin pidätykseen maissamme.