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CONTENT OF EXCHANGEABLE CATIONS IN ALBIC LUVISOLS IN REPUBLIC OF MACEDONIA UNDER DIFFERENT VEGETATIVE COVER

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ABSTRACT: Main goal of the examinations presented in this paper is to conduct in depth analysis of adsorption complex of albic luvisols in Republic of Macedonia, with a special emphasis on the content of exchangeable cations. On several location of the country, 23 soil profile of albic luvisols were excavated; 15 soil profiles under forest vegetation, 4 under grass vegetation and 4 under cultivated crops.

The results derived during the investigations showed that CEC has its highest values in the surface horizon of albic luvisols under forest vegetation (high percentage of organic matter), lower values of CEC are determined in soil profiles under grass vegetation, while the lowest values of this parameter were obtained in cultivated albic luvisols (intensive decomposition of organic matter due to cultivation).

Albic luvisols uder forest vegetation have lower values of sum of exchangeable basic cations, higer sum of acid cations (H^+ + Al^{+++}) and lower values of base saturation percentage (V%). In all examinated soil profiles of albic luvisols predominant cation is calcium, magnesium have smaller quantities wile the quantities of potassium and sodium are neglegible.

Keywords: albic luvisol, cation exchange capacity, exchangeable basic cationect

1 INTRODUCTION

The content of exchangeable ions is significant indicator for the soil formation conditions. Many processes and characteristics of soil depend of cation exchange capacity (CEC) and it's content.

Data regarding the content of the exchangeable ions of albic luvisols in R. of Macedonia can be finding in the previous work of [5, 8, 10, 11, and 12]. After revision of previous work, we couldn't find data regarding the content of adsorbed ions of albic luvisols developed under different vegetative cover in R. of Macedonia. Due to that have conducted a detailed research of the content of exchangeable ions under forests and grass vegetative cover and cultivated albic luvisol and to contribute towards better exploration of this soil type. The aim of this research is to investigate the impact of forest, grassland and cultural vegetation on the content of exchangeable cations in albic luvisols in Republic of Macedonia.

2 MATERIAL AND METHODS

On different locations of the country, 23 soil profiles of albic luvisols were excavated and morphologically described on the field. More than half of soil profiles (15) were under forest vegetation, 4 soil profiles were under grass and the other 4 on arable land.

Field examinations have been performed according to accepted methods in Former Yugoslavia [13].

The laboratory analyses have been done according to the standard adopted methods in Former Yugoslavia and Republic of Macedonia, as follows:

Mechanical composition of soil has been determined by pipette method [9]; the dispersion of the particles has been done with 0,4N Na-pyrophosphate. The separation of the mechanical elements in fractions has been done by the international classification [6].

- pH (reaction) of the soil solution has been determined with glass electrode in water suspension and in NKCI suspension [6].
- The total N has been determinate by Kjeldahl micromethod [1].
- Easy available forms of P_2O_5 and K_2O were determinate by Al method [4]
- The content of humus has been determinate at the base of total carbon by the method of Tjurin modified by Simakov [7]
- Extraction with barium chloride three-ethanolamine in glass colons (Melich method) was used for quantification of acid exchangeable cations (H^+ + Al^{+++}). The extract is titrated with 0,04 N HCl in a presence of mixed indicator [1]
- Extraction with BaCl2 (Hendershot and Duquette method [16]) was used for quantification of the exchangeable cations (Ca^{++}, Mg^{++}, K^+, Na^+). Readouts were accomplished on AAS, “Varian”.

Cation exchange capacity (T), sum of basic exchangeable cations, and base saturation percentage (BSP) as well as the percentage of particular ions saturation were calculated.

3 RESULTS AND DISCUSSION

In order to give a correct interpretation of the results for CEC and the content of exchangeable cations of albic luvisols formed under different vegetative cover, a detailed overview of the mechanical composition and some chemical properties will be given. Average results of 15 soil profiles under forest vegetation, 4 soil profiles under grass and 4 soil profiles on arable land are presented in Table 1 and 2.

Cation exchange capacity is directly correlated with total amount of clay minerals, SOM and reaction of extracting solution used for its quantification [14].

CEC data of the examined albic luvisoil profiles are presented in Table 3. Out of the presented data, differences in CEC between particular horizons can be observed. These differences are mainly due to the higher SOM accumulation in topsoil, leaching (translocation) of clay minerals from topsoil and eluvial (E horizon) into the argiluvic (Bt horizon), layer structure of the sediments, cultivation and the inherit quantum of clay minerals from the previous stadium of soil evolution.

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Table I: Mechanical composition of albic luvisol

Hor.	Skeleton > 2mm	Coarse sand 0,2-2mm	Fine sand 0,02-0,2mm	Silt 0,002-0,02mm	Clay <0,002 mm
			Grass vegetation		
A	7.79	11.50	52.53	22.48	13.50
E	12.29	11.78	51.28	23.45	13.50
Bt	6.11	8.41	40.50	20.10	30.99
BtC	9.51	15.30	29.90	30.10	24.70
C	8.17	7.55	43.00	16.20	33.25
			Arable land		
Ap	8.60	8.70	38.70	27.10	25.50
Bt	2.57	5.25	27.26	21.13	46.36
BtC	4.50	3.40	22.43	22.90	51.27
C	1.65	6.67	30.97	14.90	47.47
			Forest vegetation		
A	8.90	11.26	47.94	25.01	15.79
E	15.63	11.74	44.11	27.26	16.89
Bt	8.09	8.35	36.99	23.42	31.24
BtC	5.11	8.62	40.42	20.32	30.64
C	6.87	11.31	39.44	20.09	29.16

Table II: Chemical properties of albic luvisol

Hor.	SOM %	C/N	pH		Total	Easy av. mg/100g	
			H_2O	NKCl	N%	P_2O_5	K_2O
			Grass vegetation				
A	4,52	10,14	5,93	4,95	0,26	2,05	23,85
E	2,10	9,42	5,79	4,66	0,13	<1	14,25
Bt	0,98	8,14	5,89	4,55	0,08	<1	14,63
BtC	0,77	4,47	6,95	5,65	0,10	<1	10,30
C	0,54	9,69	6,20	4,65	0,04	<1	15,75
			Arable land				
Ap	2,65	7,52	5,81	4,78	0,20	11,75	32,40
Bt	0,92	6,21	6,01	4,92	0,09	3,44	28,56
BtC	0,80	6,29	5,95	4,90	0,08	<1	22,60
C	0,48	5,05	6,80	5,73	0,06	<1	22,60
			Forest vegetation				
A	7,10	13,45	5,56	4,61	0,30	6,37	28,67
E	2,07	10,71	5,23	4,00	0,11	<1	12,89
Bt	0,90	8,38	5,45	4,07	0,07	<1	16,20
BtC	0,64	7,44	5,53	4,08	0,05	<1	18,42
C	0,43	6,29	5,93	4,61	0,05	<1	18,20

Cation exchange capacity has its highest values in topsoil of the soil profiles formed above the forest vegetation (21,17 cmol (+) kg^{-1} soil) due to high SOM percentage, and in soil profiles formed under grass vegetation (18,10 cmol (+) kg^{-1} soil), while its lowest values were found in soil profiles on cultivated sites (14,65 cmol (+) kg^{-1} soil) which is result of intensive mineralization of SOM. The decreasing of CEC in eluvial horizon is much more intensive in soils under forest vegetation (11,98 cmol (+) kg^{-1}soil) than in albic luvisols under grass vegetation. (13,04 cmol (+) kg^{-1} soil). This is result of rapid decreasing of SOM quantity in the eluvial horizon of albic luvisols under forest vegetation. There are slight differences in CEC values between horizons Bt, BtC and C which are mainly result of the character of clay minerals and its content.

It should be noticed that CEC in argiluvic (Bt) horizon of soils under forest and grass vegetation is lower in comparison with surface horizon, while in soil profiles on cultivated sites CEC in topsoil is lover than in Bt horizon. Despite the high content of clay in Bt horizon of albic luvisols under forest and grass vegetation, its CEC has lower values than in topsoil, which is due to the high SOM in surface horizon A. Cultivated soils have lower content of organic matter hor. Ap, so the influence of humus on CEC is low.

Table III: Exchangeable cations content in albic luvisol

Hor.	Exchangeable cations in cmol (+)kg^{-1} soil					
	Ca^{2+}	Mg^{2+}	K^+	Na^+	S	H^++Al^{3+}
			Grass vegetation			
A	8,40	2,23	0,44	0,27	11,33	6,78
E	5,83	1,65	0,20	0,14	7,81	5,23
Bt	6,73	2,17	0,17	0,27	9,40	6,04
BtC	8,92	2,38	0,17	0,21	11,67	3,10
C	7,04	1,69	0,15	0,35	9,21	5,30
			Arable land			
Ap	6,54	1,48	0,49	0,17	8,68	5,98
Bt	7,05	2,15	0,32	0,25	9,77	6,20
BtC	9,65	2,69	0,23	0,21	12,78	8,77
C	8,82	2,20	0,17	0,24	11,42	4,63
			Forest vegetation			
A	7,15	2,36	0,47	0,22	10,19	10,98
E	3,47	1,43	0,16	0,17	5,23	6,75
Bt	5,05	2,35	0,18	0,24	7,81	8,40
BtC	5,04	1,98	0,15	0,18	7,35	7,24
C	4,96	1,65	0,17	0,20	6,97	7,01

The sum of basic cations mainly depends on CEC and percentage of base saturation (BSP). Cultivated albic luvisol and those under grass vegetation have higher average values of sum of basic cations in comparison with albic luvisols under forest vegetation which is a result of so called biological accumulation of basic ions. Opposite to this, the exchangeable acid cations (H^+ + Al^{+++}) shows higher values in soils under forest vegetation in comparison with cultivated albic luvisols and those under grass vegetation. The process of acidification is more intensive in soil profiles under forest vegetation, therefore sum of basic cations is low, while acid cattions have high values

Base saturation percentage (BSP) has lower values in albic luvisols under forest vegetation than cultivated and soils under grass vegetation. Albic luvisols under forest vegetation are formed on higher altitudes with higher annual precipitations. This situation coupled with the modest content of basic cations in forest litter leads to poor content of basic cations and more intensive process of acidification in this soil profiles in comparison to the soil profiles under cultivation and grass vegetation.

In cultivated albic luvisols, basic materials are incorporated with application of fertilizers. This is another reason for base saturation of these soils.

The quantity of particular adsorbed ions in albic luvisols is significantly related to the parent material mineralogical content, or more precisely what type of decaying products are predominant in parent material: basic, acid of carbonate rocks products.

Table IV: Percentage of exchangeable cations in albic luvisol

Hor.	Exchangeable cations in % of T					T	V%
	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	$H^{+}+Al^{3+}$		
Grass vegetation							
A	46,30	12,29	2,47	1,52	37,43	18,10	62,56
E	44,28	12,39	1,63	1,17	40,55	13,04	59,44
Bt	43,17	13,91	1,09	1,89	39,67	15,44	60,33
BtC	60,38	16,11	1,13	1,42	20,98	14,77	79,02
C	51,45	11,85	1,05	2,58	33,08	14,51	66,92
Arable land							
Ap	42,76	9,69	3,23	1,17	43,16	14,65	56,84
Bt	44,51	13,79	2,09	1,83	37,78	15,97	62,22
BtC	43,61	12,24	1,16	0,97	42,02	21,54	57,98
C	62,47	14,98	1,17	2,16	19,22	16,05	80,78
Forest vegetation							
A	35,79	11,76	2,36	1,13	48,96	21,17	51,04
E	28,88	11,98	1,25	1,42	56,41	11,98	43,59
Bt	32,17	14,76	1,12	1,51	50,44	16,21	49,56
BtC	37,80	14,18	1,08	1,22	45,73	14,59	54,27
C	38,76	12,23	1,24	1,39	46,38	13,98	53,63

Bistratification of the soil profile and the pedogentic process also have an important influence on the content of adsorbed ions. With the processes of debasification and acidification the adsorbed basic ions from hor. A and E are leached and translocated into hor. Bt, BtC and C. For the soil under natural vegetation so called biological accumulation have an important rolle on accumulation of basic ions in hor. A. In cultivated albic luvisols the content of adsorbed ions is significantly changes due to the mixing of genetic horizons which have different content of adsorbed cations. Total content of adsorbed ions expressed in cmol (+) kg^{-1} soil will depend on the quantity of SOM, clay minerals content and the caracter of clay minerals [15].

Generally speaking in all examined profiles of albic luviosls dominant cation is Ca, and Mg, while potassium and sodium are presented with minimum quantities. Some slight differences of this parametar were determined between cultivated albic luvisols and soils under forest and grass grass vegetatin (table 3).

In all horizons the content of exchangeable Ca (% of T) is lower in the exeminated albic luvisols under forest vegetation in comparison to the cultivated and albic luvisols under grass vegetation, whille the content of acid cations is higher in soils under forest vegetation. Culivated albic luvisols and those under grass vegetation contains higher quantities of exchangeable Ca and lower content of acid cations, mainly due to the weaker process of acidification on lower altitudes and higher biological acummulation of Ca originated from grass vegetation and remains from cultuvated crops. According Jarceva [2,3] cultivation and the input of fertilizers have influence on decrease of exchangeable acidity.

The higest content of exchangeable K^{+} was detected in cultivated albic luvisols and is result of input of organic and mineral fertilizes.

4 CONCLUSION

Cation exchange capacity in argiluvic hor. Bt in soil profiles under forest and grass vegetation cover is lower in comparison to surface horizon. In cultivated soil profiles an opposite situation was detected, CEC is lower in topsoil and increase in Bt horizon.

The sum of basic cations have higher values in cultivated soils and soils under grass vegetation in comparison to albic luvisols under forest, while the exchangeable acid cations have higher values in soil under forest in comparison to the cultivated soils and soils under grass vegetation.

The examined albic luvisosl profiles under forest vegetation have lower base saturation percentage in comparison to the cultivated and soil under grass vegetation.

In all examined profiles of albic luvisols the dominant exchangeable cation is Ca, the next cation with slightly lower content is Mg, while the content of potassium and sodium in CEC is negligible.

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