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DETERMINATION OF MINERAL COMPOSITION IN THE ALFALFA (*Medicago sativa* L.) COLLECTED FROM DIFFERENT REGIONS IN THE REPUBLIC OF NORTH MACEDONIA

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Abstract

The role of alfalfa (*Medicago sativa* L.), as the highest quality forage culture, in the development of agricultural production and the intensification of forage production is due to the ability to ensure high yield, has the ability to regenerate continuously and possess high nutritional value. The crops of alfalfa were analyzed from different locations in Tetovo, Skopje and Ovche Pole regions on the territory of the Republic of North Macedonia. For proper growth and development, it is necessary to have a sufficient amount of mineral matter in the soil. AAS (atomic absorption spectrophotometry) is used to determine the mineral composition. The experimental part in which the determination of the presence of mineral matter was made, according to the results of the measurements in the slopes and regions, only the manganese in the second slope was shown a significant difference between two groups: Tetovo region and the second group - Skopje and Ovche Pole region for $p < 0.05$. Also, the iron in the second slope was shown a significant difference for $p < 0.05$ between two groups of regions: the first group Tetovo region and the second group Skopje and Ovche Pole region.

From the examination it follows that the representation of macro and micro elements meets the basic criteria and that alfalfa can be recommended for growing in the examined regions, thus obtaining high yield and good quality.

Plant nutrition is the basis for obtaining high quality crop production.

Key words: *forage culture, mineral matter, macroelements, microelements*

INTRODUCTION

One of the most important processes in the growth and development of plants is the physiology of mineral nutrition. Mineral nutrients are essential for normal life of plants and animals. Plant nutrition through the root system is better known as plant mineral nutrition. The mineral nutrition of plants is the absorption of mineral elements from the external environment and their involvement in the physiological processes in the plant (Angeleska et al., 2011). Nutrients are all those chemical elements necessary for the normal growth and development of plants. The availability of minerals in the soil is important, as it affects the productivity of agric. crops. In our research the forage crop of alfalfa (*Medicago sativa* L.) is examined. It is one of the most widespread, most important and best quality perennial leguminous forage crops. Alfalfa is of very high nutritional quality as animal feed. It is characterized by the ability to ensure high yield and quality protein food, possesses high nutritional value and it has the ability to regenerate itself continuously (Julier et al., 2000). Alfalfa abounds with high content of raw proteins and is of excellent quality, thereby it surpasses almost all perennial forage plants (Dinic et al., 2005). Alfalfa is enriched with vitamins, carbohydrates, saponins, mineral elements and other active components of vital importance, essential for the growth and development of animals (Hao et al., 2008).

Alfalfa captures large amounts of nitrogen, one part of it is obtained through the soil, and the other part is accumulated by the symbiotic nitrogen fixation of the natural atmospheric nitrogen with the help of Rhisobium meliloti var. medicaginis (Ivanovski, 2000).

With the numerous scientific experiments, it is established that 17 chemical elements are essential for the life of plants. These are the elements that participate in the construction of plants that are often grouped, based on their presence in plants. That is why they are called necessary, essential or biogenic elements that are divided into macro and micro elements. Besides the essential elements, the plants can also absorb useful or beneficial elements and harmful (toxic) elements. The mineral elements, are part of many organic compounds, they participate in biochemical reactions and are important factors for maintaining the integrity of the cell and its parts (Spasenoski and Gadžovska-Simic, 2009).

For the proper growth and development of crops, a sufficient amount of macro and micro elements in the soil, available for the plants, is necessary. The meaning of the prefixes macro and micro only shows the needed quantity of a certain element without which the plants could not complete their life cycle if there is any deficiency in both of them, and in no way shows the general significance, because for the life of plants each of the previously mentioned 17 elements is necessary (Trajkova et al., 2017).

According to the way of their participation in the plant metabolism micro elements significantly differ from most macro elements. Namely, their effect is predominantly catalytic. They act on plants at very low concentrations, often strictly specific. However, their composition in the dry matter of plants is negligible compared to some constitutional macro elements (C, N and P) (Cvetanovska et al., 2015).

Plant nutrition is an agro-technical measure that replenishes nutrient reserves in the soil needed for growth, development and fruit-bearing of the plants Jekik (1983). Proper nutrition increases plant resistance to diseases and pests, as well as to high and low temperatures. It also has a positive impact on the quantity and quality of crop yields (Avramov 1999, Pemovski 1981).

MATERIAL AND METHOD

Plant material

The object of the examination was alfalfa (*Medicago sativa* L.), collected from three different regions, in three slopes on the territory of the Republic of North Macedonia:

- **Tetovo region:** Bogovinje, Vrutok, Dzepchishte, Galate, Zelino, Pechkovo and Jegunovce;
- **Skopje region:** Avtokomanda, Sopishte, Drachevo, Saraj, Radishani, Vlae and Glumovo and
- **Ovche Pole region:** Cheshinovo, Karbinci, Obleshevo, Lozovo and Mustafino.

The material was collected during the vegetative cycle of alfalfa. The experiments were carried out on prepared matrix solution using atomic absorption spectrophotometry (AAS). The experiment used a measured dry plant material of 1 g, which was then transferred to a combustion flask. Three repetitions have been made for AAS analysis.

Method for determination of mineral composition

In plants mineral nutrients are obtained by combustion of organic matter at high temperature. The method for determining the mineral elements in the plant material includes: combustion of organic matter, preparation of the matrix solution and quantitative determination of the mineral elements in the matrix solution.

The chemical analysis in the mineral part of the plant material is done after the combustion of the organic matter. The combustion of the organic matter can be both dry and wet. The method of dry combustion of the plant material is carried out in a high temperature furnace (450-550°C) for 60-90 minutes. During this process, organic substances combust and separate as a gas form CO_2, N_2, H_2O and the unburnt mineral part remains in a form of white ash. If the ash contains black spots that originate from the non-combustible organic matter, then several crystals of ammonium nitrate or several drops of alcohol are added. The wet combustion method includes treatment of the plant material with strong mineral acids. The dried and grinded plant material (1 g) is put in a combustion flask. Then 10 ml of the combustion mixture are added to the flask and the flask is placed on a sand bath. When white steam starts to emerge from the flask, the combustion of the organic matter is completed. At the end of the combustion process, the mineral residue (white sediment) is repeatedly rinsed with distilled water and collected in 100 ml measuring flasks. The prepared solution is a matrix solution used to quantify the content of the mineral elements. When it comes to determining mineral composition, chemical methods increasingly give place to the various instrumental methods, such as AAS (atomic absorption spectrophotometry).

The AAS conditions for analysis of the metals are that the determination procedure itself is relatively simple, has high specificity, low detection limit for a large number of elements, which is very important when working with diluted solutions or with samples in which the elements to be determined are traced, possibility to determine a number of elements from one single solution, the possibility that a greater number of elements be determined by the same instrument, the duration of the analysis is short, the determination speed is large, which is undoubtedly one of the greatest advantages of AAS in relation to conventional chemical methods. This method allows direct results to be obtained.

The concentration area in which the AAS can be applied is very wide. Traces of metal by this method are very well determined. Also, the samples that contain up to 50% tested components are successfully analysed.

The concentrations determined in the samples must correspond to areas of the highest analytical accuracy. It is believed that this area is usually 20 to 200 times the value of the detection limit, although concentrations close to the detection limit can still be determined, but with less accuracy. Thus, when determining the trace elements, which are usually present in quantities close to the detection limits, the expected error is proportionately higher. The accuracy of the analysis undoubtedly depends on the extent to which the avoidance of chemical nature is avoided as well as the attention with which the sample is prepared for analysis, especially when determining the components present at higher concentrations than the optimum for this type of determination. With AAS today, a large number of elements can be determined.

Statistical analysis

For statistical processing of the research results, a software programme Statistical Package for Social Sciences (IBM SPSS Statistics Software v.23) with a one-way analysis of variance (ANOVA) was used in order to determine the significant differences ($p<0.05$) between the arithmetic features of the samples. Subsequent studies were made and the results were Post-Hoc analysed using the Duncan`s multiple range test. The test is used to determine the significance of the difference between the tested minerals and their diversity level ranging from 0.05% and 0.01%. A Karl Pearson`s coefficient of correlation between localities and regions was also used.

RESULTS AND DISCUSSION

Contents of mineral elements in the first slope

The results obtained from the determination of mineral elements are presented. We investigated the mineral elements: Na, K, Ca, Mg, Mn, Zn, Cu and Fe in alfalfa (*Medicago sativa* L.). Table 1 shows that in the first slope, can be seen, in which region was registered the highest and in which the lowest content of the examined elements. One of the tested useful elements was Na, which has the highest measured content in the Ovche Pole region and the lowest in the Skopje region. From the examined macro elements Ca, Mg and K, calcium has the highest measured content in Ovche Pole region, and magnesium has the lowest measured in Tetovo region. From the examined micro elements Fe, Mn, Zn and Cu, the highest level of iron was measured in Ovche Pole region, and the lowest level of copper was measured in the Tetovo region.

Table 1. Contents of mineral elements (mg/kg per dry matter) in alfalfa (*Medicago sativa* L.) from the examined regions in the territory of the Republic of North Macedonia in the first slope.

Regi-ons	Na		K		Ca		Mg		Mn		Zn		Cu		Fe	
	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD
Tetovo	241	±179	19138	±14408	45546	±64106	1070	±443	27	±17	17	±8	4	±1	641	±669
Skopje	201	±94	7936	±11032	52150	±88043	1235	±298	25	±14	23	±21	5	±1	386	±313
Ovche Pole	464	±389	14165	±14838	53060	±81883	1433	±427	29	±15	13	±2	4	±0	647	±470
All regions	285	±244	13702	±13534	49957	±73863	1226	±396	27	±15	18	±14	4	±1	548	±497

In the first slope in the Tetovo region, it was shown strong positive significant correlations the following pairs of elements: Mg-Mn (r =0.808, p=0.028 <0.05), Mg-Cu (r=0.773, p=0.042 <0.05) and Mn- Fe (r =0.785, p=0.036 <0.05).

In the first slope in the Skopje region, it was shown strong positive significant correlations the following pairs of elements: Mg-Mn (r=0.898, p=0.006 <0.05), Mg-Zn (r=0.882, p=0.009 <0.05) and Mg-Cu (r=0.910, p=0.004 <0.05), Mg-Fe (r =0.945, p=0.001 <0.05), Mn-Zn (r=0.945, p=0.001<0.05), Mn-Cu (r=0.859, p=0.013<0.05), Mn-Fe (r=0.926, p=0.003 <0.05), Zn-Cu (r =0.774, p=0.041<0.05), , Zn-Fe (r =0.898, p=0.006 <0.05), Cu-Fe (r =0.783, p=0.037 <0.05).

In the first slope in the Ovche Pole region, it was shown strong positive significant correlations the following pairs of elements: Na-K (r=0.928, p=0.023<0.05) and Mn-Fe (r=0.947, p=0.015 <0.05).

Table 2. Correlation between the elements in the first slope, in the three examined regions.

		Na	K	Ca	Mg	Mn	Zn	Cu	Fe
Na	Pearson Correlation	1	0.262	0.162	-0.098	0.161	-0.183	0.054	0.211
	Sig. (2-tailed)		0.278	0.508	0.689	0.511	0.452	0.825	0.386
K	Pearson Correlation	0.262	1	-0.055	-0.228	-0.185	-0.203	-0.016	-0.088
	Sig. (2-tailed)	0.278		0.824	0.347	0.449	0.404	0.948	0.721
Ca	Pearson Correlation	0.162	-0.055	1	-0.240	-0.146	0.030	-0.108	-0.153
	Sig. (2-tailed)	0.508	0.824		0.322	0.551	0.904	0.660	0.533
Mg	Pearson Correlation	-0.098	-0.228	-0.240	1	**0.725****	0.241	**0.492***	**0.513***
	Sig. (2-tailed)	0.689	0.347	0.322		0.000	0.321	0.032	0.025
Mn	Pearson Correlation	0.161	-0.185	-0.146	0.725**	1	0.404	0.359	**0.821****
	Sig. (2-tailed)	0.511	0.449	0.551	0.000		0.086	0.131	0.000
Zn	Pearson Correlation	-0.183	-0.203	0.030	0.241	0.404	1	0.435	0.281
	Sig. (2-tailed)	0.452	0.404	0.904	0.321	0.086		0.063	0.243
Cu	Pearson Correlation	0.054	-0.016	-0.108	**0.492***	0.359	0.435	1	0.297
	Sig. (2-tailed)	0.825	0.948	0.660	0.032	0.131	0.063		0.216
Fe	Pearson Correlation	0.211	-0.088	-0.153	**0.513***	**0.821****	0.281	0.297	1
	Sig. (2-tailed)	0.386	0.721	0.533	0.025	0.000	0.243	0.216	
**. Correlation is significant at the 0.01 level									
*. Correlation is significant at the 0.05 level									

In the first slope, all regions together, in Table 2, it was shown strong positive significant correlations the following pairs of elements: Mg-Mn (r=0.725, p=0.000<0.05), Mg-Cu (r=0.492, p=0.032 <0.05), Mg-Fe (r=0.513, p=0.025<0.05) and Mn-Fe (r=0.821, p=0.000<0.05).

Contents of mineral elements in the second slope

Based on the results in Table 3, in the second slope, the content on one of the examined element from the group of useful elements was natrium. The highest measured value was in Tetovo region, and the lowest in Skopje region. From the examined macro elements (K, Ca and Mg), the highest measured content at the potassium in the Ovche Pole region, and the lowest of the magnesium in the Skopje region. From the examined micro elements (Mn, Zn, Cu and Fe), the highest determined content was that of iron , and the lowest of copper both in Skopje region.

Table 3. Contents of mineral elements (mg/kg per dry matter) in alfalfa *(Medicago sativa* L.) from the examined regions in the territory of the Republic of North Macedonia in the second slope.

Regions	Na		K		Ca		Mg		Mn		Zn		Cu		Fe	
	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD
Tetovo	704	761	8662	4967	13096	5062	1455	223	27	8	26	33	6	1	694	678
Skopje	116	81	8923	7159	16500	4312	1268	442	15	7	18	9	4	1	131	37
Ovche Pole	433	432	14972	10996	10565	3034	1709	770	16	6	15	5	5	1	165	96
All regions	416	551	10418	7747	13684	4765	1453	495	19	9	20	21	5	1	348	479

In the second slope in the Tetovo region, it was shown strong positive significant correlations the following pairs of elements: Mn-Zn (r =0.793, p=0.033<0.05), Mn-Fe (r =0.858, p=0.014 <0.05), Zn-Cu (r =0.772, p=0.042<0.05) and Zn-Fe (r =0.966, p=0.000<0.05).

In the second slope in the Skopje region, the elements did not show a significant correlations, but in the Ovche Pole region, it was shown strong positive significance correlation only the pairs of elements: K-Mg (r = 0.899, p = 0, 038 <0.05).

Table 4. Correlation between the elements in the second slope, in the three examined regions.

		Na	K	Ca	Mg	Mn	Zn	Cu	Fe
Na	Pearson Correlation	1	0.000	-0.265	-0.069	0.002	-0.105	0.104	-0.014
	Sig. (2-tailed)		0.998	0.272	0.778	0.994	0.669	0.673	0.954
K	Pearson Correlation	0.000	1	**-0.458***	0.378	-0.165	-0.048	-0.329	-0.091
	Sig. (2-tailed)	0.998		0.048	0.111	0.499	0.844	0.169	0.710
Ca	Pearson Correlation	-0.265	**-0.458***	1	-0.255	-0.121	-0.331	-0.344	-0.353
	Sig. (2-tailed)	0.272	0.048		0.292	0.623	0.166	0.149	0.138
Mg	Pearson Correlation	-0.069	0.378	-0.255	1	0.439	-0.060	-0.170	0.040
	Sig. (2-tailed)	0.778	0.111	0.292		0.060	0.808	0.487	0.869
Mn	Pearson Correlation	0.002	-0.165	-0.121	0.439	1	**0.488***	0.357	**0.760****
	Sig. (2-tailed)	0.994	0.499	0.623	0.060		0.034	0.134	0.000
Zn	Pearson Correlation	-0.105	-0.048	-0.331	-0.060	0.488*	1	**0.511***	**0.858****
	Sig. (2-tailed)	0.669	0.844	0.166	0.808	0.034		0.025	0.000
Cu	Pearson Correlation	0.104	-0.329	-0.344	-0.170	0.357	**0.511***	1	**0.626****
	Sig. (2-tailed)	0.673	0.169	0.149	0.487	0.134	0.025		0.004
Fe	Pearson Correlation	-0.014	-0.091	-0.353	0.040	**0.760****	**0.858****	**0.626****	1
	Sig. (2-tailed)	0.954	0.710	0.138	0.869	0.000	0.000	0.004	
*. Correlation is significant at the 0.05 level									
**. Correlation is significant at the 0.01 level									

In the second slope, all regions together, in Table 4, it was shown positive significant correlation in the following pairs of elements: Mn-Fe (r=0.760, p=0.000<0.05) strong correlation, Zn-Cu (r=0.511, p=0.025<0.05) medium strong correlation, Zn-Fe (r=0.858, p=0.000<0.05) strong correlation and Cu-Fe (r=0.626, p=0.004<0.05) medium strong correlation. The K-Ca couple (r=0.458, p=0.048<0.05) was shown a significantly week negative correlation.

Content of mineral elements in the third slope

The content of the examined minerals is shown in Table 5, where the highest and the lowest levels of presence of macro and micro elements can be seen, as well as that of one of the useful examined elements in the analysed regions. The highest level of sodium content was measured in the Skopje region, and the lowest in Ovce Pole region. From the macro elements the highest specific content was that of calcium in Tetovo region, and the lowest magnesium content was measured in the Ovche Pole region. From the micro elements, the highest content of iron was measured in Ovche Pole region, and the lowest content of copper in Skopje region.

Table 5. Contents of mineral elements (mg/kg per dry matter) in alfalfa (*Medicago sativa* L.) from the examined regions in the territory of the Republic of North Macedonia in the third slope.

Regions	Na		K		Ca		Mg		Mn		Zn		Cu		Fe	
	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD
Tetovo	467	±328	11850	±7373	17989	±5797	1265	±140	23	±4	20	±8	5	±1	137	±46
Skopje	477	±562	9605	±5288	17089	±4261	1396	±483	19	±10	19	±11	4	±1	123	±67
Ovche Pole	212	±52	12642	±5729	13030	±7308	1258	±705	22	±5	19	±6	5	±1	148	±106

In the third slope in the Tetovo region, it was shown strong significant negative correlations in the following pairs of elements: Na-K (r=0.803, p=0.030<0.05) and Ca-Fe (r=0.853, p=0.015 <0.05).

In the third slope in the Skopje region, it was shown strong positive correlations pairs of elements: Mg-Zn (r=0.939, p=0.002 <0.05), Mg-Cu (r=0.814, p=0.026 <0.05) and Zn-Cu (r=0.783, p=0.037 <0.05). A strong significant negative correlation was shown the pairs of elements: Zn-Fe (r=0.773, p=0.042 <0.05).

In the third slope in the Ovche Pole region, it was shown strong positive correlations the following pairs of elements: K-Mg (r=0.906, p=0.034 <0.05) and K-Fe (r=0.916, p=0.029 <0.05). A strong significant negative correlation was shown the pairs of elements: Mn-Zn (r=0.895, p=0.040 <0.05).

Table 6. Correlation between the elements in the third slope, in the three examined regions.

		Na	K	Ca	Mg	Mn	Zn	Cu	Fe
Na	Pearson Correlation	1	-0.251	0.191	0.285	0.170	0.152	0.228	-0.101
	Sig. (2-tailed)		0.300	0.432	0.236	0.487	0.534	0.347	0.680
K	Pearson Correlation	-0.251	1	-0.213	0.063	0.082	0.056	0.240	**0.641****
	Sig. (2-tailed)	0.300		0.380	0.797	0.738	0.820	0.323	0.003
Ca	Pearson Correlation	0.191	-0.213	1	0.056	-0.002	-0.327	-0.361	-0.273
	Sig. (2-tailed)	0.432	0.380		0.820	0.992	0.171	0.129	0.259
Mg	Pearson Correlation	0.285	0.063	0.056	1	-0.003	**0.498***	0.371	0.065
	Sig. (2-tailed)	0.236	0.797	0.820		0.990	0.030	0.118	0.793
Mn	Pearson Correlation	0.170	0.082	-0.002	-0.003	1	0.010	0.093	0.112
	Sig. (2-tailed)	0.487	0.738	0.992	0.990		0.968	0.705	0.647
Zn	Pearson Correlation	0.152	0.056	-0.327	**0.498***	0.010	1	**0.488***	-0.210
	Sig. (2-tailed)	0.534	0.820	0.171	0.030	0.968		0.034	0.388
Cu	Pearson Correlation	0.228	0.240	-0.361	0.371	0.093	**0.488***	1	0.001
	Sig. (2-tailed)	0.347	0.323	0.129	0.118	0.705	0.034		0.998
Fe	Pearson Correlation	-0.101	**0.641****	-0.273	0.065	0.112	-0.210	0.001	1
	Sig. (2-tailed)	0.680	0.003	0.259	0.793	0.647	0.388	0.998	

**. Correlation is significant at the 0.01 level

*. Correlation is significant at the 0.05 level

In the third slope, all regions together, in Table 6, it was shown medium strong significant positive correlations of the following pairs of elements: K-Fe (r =0.641, p=0.003 <0.05), Mg-Zn (r =0.498, p=0.030 <0.05) and Zn- Cu (r =0.488, p=0.034 <0.05).

The content of the mineral elements in all the slopes together

From the results shown in Table 7, it can be seen that the highest measured sodium content was in Tetovo region, and the lowest in Skopje region. From the macro elements the highest calcium content was measured in Skopje region, and the lowest magnesium content in Tetovo region. From the micro elements the highest iron content was measured in Tetovo region, and the lowest copper content in Skopje region.

Table 7. Contents of mineral elements (mg/kg per dry matter) in alfalfa (*Medicago sativa* L.) from the examined regions in the territory of the Republic of North Macedonia for all slopes together.

Regi-ons	Na		K		Ca		Mg		Mn		Zn		Cu		Fe	
	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD	Mean value	SD
Tetovo	471	±503	13217	±10304	25544	±38274	1263	±325	26	±11	21	±20	5	±1	491	±582
Skopje	265	±352	8821	±7795	28580	±51266	1300	±400	20	±11	20	±14	4	±1	213	±216
Ovche Pole	370	±333	13926	±10384	25552	±48374	1467	±633	23	±11	16	±5	5	±1	320	±355
All regions together	368	±413	11784	±9585	26664	±45266	1330	±450	23	±11	19	±15	5	±1	344	±429

Table 8. Contents of micro and macro elements (mg/kg per dry matter) which are significant different at the three examined regions in all done sloping of alfalfa.

Slopes	Regions	Na	K	Ca	Mg	Mn	Zn	Cu	Fe
		Mean value	Mean value	Mean value	Mean value	Mean value	Mean value	Mean value	Mean value
1	Tetovo	241[a]	19138[a]	45546[a]	1070[a]	27	17[a]	4[a]	641[a]
	Skopje	201[a]	7936[a]	52150[a]	1235[a]	25	23[a]	5[a]	386[a]
	Ovche Pole	464[a]	14165[a]	53060[a]	1433[a]	29	13[a]	4[a]	647[a]
2	Tetovo	704[a]	8662[a]	13096[a]	1455[a]	27[b]	26[a]	6[a]	694[b]
	Skopje	116[a]	8923[a]	16500[a]	1268[a]	15[a]	18[a]	4[a]	131[a]
	Ovche Pole	433[a]	14972[a]	10565[a]	1709[a]	16[a]	15[a]	5[a]	165[a]
3	Tetovo	467[a]	11850[a]	17989[a]	1265[a]	23[a]	20[a]	5[a]	137[a]
	Skopje	477[a]	9605[a]	17089[a]	1396[a]	19[a]	19[a]	4[a]	123[a]
	Ovche Pole	212[a]	12645[a]	13030[a]	1258[a]	22[a]	19[a]	5[a]	148[a]
All slopes	Tetovo	471[a]	13217[a]	25544[a]	1263[a]	26	21[a]	5[a]	491[a]
	Skopje	265[a]	8821[a]	28580[a]	1300[a]	20[a]	20[a]	5[a]	213[a]
	Ovche Pole	370[a]	13926[a]	25552[a]	1467[a]	23[a]	16[a]	5[a]	320[a]

Means within each column having different letters are significantly different according to Duncan's test at $p<0.05$

Means within each column having different numbers are significantly different according to Duncan's test at $p<0.01$

According to the results of measurements by slopes and regions, (Table 8), only Mn in the second slope was shown a significant difference between two groups: Tetovo and the second group - Skopje and Ovche Pole region for $p<0.05$. Also, the iron in the second slope was shown a significant difference for $p<0.05$ between two groups of regions: one Tetovo region and the second group Skopje and Ovche Pole region.

CONCLUDING REMERKS

Modern agricultural production, strives to obtain higher yields of good quality, as well as products that are health-safe and environmentally sound, by the proper use of mineral nutrition. Based on the theoretical framework of the topic, as well as the experimental part in which the determination of the presence of mineral elements is made, the following conclusions can be drawn:

- In the first slope, all regions together, it was shown strong positive significant correlations the following pairs of elements: Mg-Mn ($r=0.725$, $p=0.000 <0.05$), Mg-Cu ($r=0.492$, $p=0.032 <0,05$), Mg-Fe ($r=0.513$, $p=0.025 <0.05$) and Mn-Fe ($r=0.821$, $p=0.000 <0.05$).
- In the second slope, all regions together,it was shown positive significant correlation

in the following pairs of elements: Mn-Fe (r=0.760, p=0.000 <0.05) strong correlation, Zn-Cu (r= 0.511, p=0.025 <0.05) medium strong correlation, Zn-Fe (r=0.858, p=0.000 <0.05) strong correlation and Cu-Fe (r=0.626, p=0.004 <0.05) medium strong correlation. The K-Ca (r=0.458, p=0.048 <0.05) was shown a significantly week negative correlation.

- In the third slope, all regions together, it was shown significant, medium strong positive correlations in the following pairs of elements: K-Fe (r=0.641, p=0.003 <0.05), Mg-Zn (r= 0.498, p=0.030 <0.05) and Zn-Cu (r=0.488, p=0.034 <0.05).

According to the results of the measurement made in slopes and regions, only Mn in the second slope shows a significant difference between two groups: Tetovo region and the second group - Skopje and Ovce Pole region for p <0.05. Also, Fe in the second slope was shown a significant difference for p <0.05 between two groups of regions: the first group Tetovo region and the second group Skopje and Ovche Pole region.

All of the above shows that the mineral composition is satisfactory and that alfalfa can be recommended for growing in similar agro-ecological conditions, since in terms of the chemical composition and the presence of the examined macro and micro elements as well as the presence of the useful elements meets the appropriate standards, for high yield and good quality. Plant nutrition is the basis for obtaining high quality crop production.

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ОДРЕДУВАЊЕ НА МИНЕРАЛНИОТ СОСТАВ КАЈ ЛУЦЕРКА (*Medicago sativa* L.) КОЛЕКЦИОНИРАНА ОД РАЗЛИЧНИ РЕГИОНИ ВО РЕПУБЛИКА СЕВЕРНА МАКЕДОНИЈА

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Резиме

Улогата на луцерката (*Medicago sativa* L.), како најквалитетна фуражна култура, во развитокот на земјоделското производство и интензивирање на фуражното производство се должи на способноста да осигурува висок принос, има способност непрекинато да се регенерира и поседува висока хранлива вредност. Анализирани се култури на луцерка од различни локалитети во Тетовскиот, Скопскиот и Овчеполскиот регион на територијата на Република Северна Македонија. За правилен раст и развој е неопходно присуство на доволна количина на минерални материи во почвата. За одредување на минералниот состав се користи ААС (атомска апсорпциона спектрофотометрија). Во експерименталниот дел во кој е извршено одредувањето на застапеноста на минералните материи, според резултатите на мерењата по откоси и региони, единствено манганот во вториот откос покажа сигнификантна разлика меѓу две групи: Тетовскиот и втората група – Скопскиот и Овчеполскиот регион за $p<0,05$. Исто така, железото во вториот откос покажа сигнификантна разлика за $p<0,05$ меѓу две групи на региони: едната група Тетовскиот регион и втората група Скопскиот и Овчеполскиот регион. Од испитувањето произлегува дека застапеноста на макроелементите и микроелементите ги задоволува основните критериуми и луцерката може да се препорача за одгледување во испитуваните региони, а со тоа добивање на висок принос и добар квалитет.

Исхраната на растенијата е основа за добивање на висококвалитетно растително производство.

Клучни зборови: *фуражна култура, минерални материи, макроелементи, микроелементи.*