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TESTING OF THE POTASSIUM CONTENT IN THE SOIL FOR THE PURPOSE OF PRESERVING BIODIVERSITY

SUMMARY

The aim of this study was to determine the content of physiologically active potassium (K_2O) in the soil in the territory covered by the work of the Agricultural Advisory and Expert Service of Smederevo (PSSS Smederevo). Research was carried out on three locations: Velika Plana, the City of Smederevo and Smederevska Palanka, for the purpose of ensuring the optimal use of mineral and organic fertilizers, to preserve soil resources. The paper presents the results of testing the content of physiologically active potassium – K_2O. The territory of Velika Plana had most areas with harmful content, while the lowest content of K_2O was recorded in the territory of Smederevska Palanka. The results indicate that the obtained values were greatly influenced by different types of soil on the examined plots, and an anthropogenic factor was also evident. All the plots from which soil samples were taken for analysis of potassium content were mapped, and based on the obtained results farmers were given advice on the necessary remedial measures and optimal use of organic and mineral fertilizers to improve agricultural production and preserve biodiversity. Mineral nutrition is extremely important for growth, development and reaching maximum yields of cultivated plants.foliar mass were higher in the PSB version (without fertilizers), and in the treatment with the use of *P. polymyxa* - with the use of $N_{20}P_{40}$ fertilizers.

Keywords: potassium content, soil, mineral nutrition, preservation of biodiversity

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INTRODUCTION

Being a natural creation on our planet, soil is fundamental base for production of organic matter through cultivated and spontaneously grown plant species. Soil is one of the most important natural resources, priceless for all mankind. It is a limited and destructible natural resource, formed slowly yet destroyed quickly when used improperly. It is the basis for agricultural production and crucial for the survival of the living world on our planet. Soils are created as a result of pedogenetic factors, particularly of geological base, climate, relief, organic matter and the age of the terrain. Each of these factors can have a dominant influence on pedogenesis. Production value or suitability of soil for certain crop production depends not only on the content of that loose topmost layer of the Earth formed in the process of pedogenesis, but also on climatic factors of a certain region. When it comes to general soil fertility, different types are often mentioned, such as: natural soil fertility, as a result of pedogenetic factors that determine the direction and intensity of pedogenetic factors, which, again, determine the direction and intensity of pedogenetic processes taking place in the soil, and as a result of their action, more or less fertile soils are formed, soil types and their varieties; artificial fertility – resulting from anthropogenic influence, i.e. human activity; effective fertility, which includes natural and artificial fertility of soil; and potential fertility – the result of all positive and negative properties of soil. Using of soil, especially in intensive plant production, often creates a disturbance in the balance of certain factors of soil creation and damage (Popović, 2002; Ikanović *et al*., 2020). The Republic of Serbia has 5.06 million hectares of agricultural land, 71% of which is intensively used as arable land, orchards and vineyards, while 29% are natural grasslands, meadows and pastures. The dominant part of agricultural land, 3.3 million hectares or 65%, is used in the form of arable land, about 7% of which is not used annually but remains in the form of fallow soil or uncultivated land. In addition to the areas left fallow, a significant part of the areas under meadows and pastures is not used due to their inaccessibility, weed infestation or economic reasons. The correct choice of assortment for a certain production area results in larger and more stable production of cultivated plants. A significant measure of growing technology is properly balanced plant nutrients. Mineral nutrition of plants is extremely important for growth, development and achieving maximum yields of cultivated plants. NPK mineral nutrients are the main carriers of yield value. The main nutrient elements — nitrogen, phosphorus, and potassium — have major importance in plant nutrition and the greatest impact on increased technological and yield value of plants. Intensification of plants nutrition with NPK fertilizers significantly increases the total yield (Popović *et al.*, 2013; 2015; 2017; 2019; 2020; Lakić *et al.* 2018; 2019; 2020; 2022; Terzić *et al*., 2019; Kolarić *et al.*, 2021; Stojiljković *et al*., 2021; Ljubičić *et al*., 2021; 2022; Bojović *et al*., 2022; Božović *et al*., 2022; Zejak *et al.*, 2022; Filipović *et al*., 2023). Potassium is an element that plays a very important role in the life processes of plants. In addition to significantly affecting the water regime of plants, it also takes part in

osmoregulation and favorably affects the transport of assimilates. Potassium activates numerous enzymes, takes part in forming aromatic compounds, which is particularly important in vegetable and fruit production, and stimulates the synthesis of numerous compounds such as sugars, proteins, starch, cellulose, vitamins, etc. A lack of potassium can lead to a decrease in plant resistance to stressful conditions, as well as to the occurrence of diseases and pests. Our country is among lowest consumers of potassium fertilizers in Europe, and the reason for this lies in relatively good supply of soil in Serbia with this element (Simić *et al*., 2020).

In order to achieve high and stable yields and increase the quality of crops in arable, vegetable and fruit production, it is important to know both the properties of soil and the requirements of cultivated plants. Knowing these parameters enables you to implement agrotechnical and ameliorative measures correctly while preserving biodiversity (Janković *et al*., 2016; Đurić *et al.,* 2018; Lakić *et al.,* 2018; Janković *et al*., 2020; Milunović *et al*., 2022; Zejak *et al*., 2022; Bojović *et al*., 2022). Intensification of plant production, cultivation of new plant species and genotypes, introduction of new plant cultivation systems and technologies, expansion of agricultural areas even in climatic conditions that are not the most favorable for plant production, protection of the environment from pollution, and new requirements for product quality constantly impose new and increasingly complex problems related to plant nutrition. In order to solve them, it is necessary to know, among other things, some basic principles but also new scientific and practical knowledge in the field of mineral nutrition of plants, and within that, to have insight into the role of certain elements in the life processes of plants. Optimum mineral nutrition of plants is not only expected to achieve maximum, economically profitable yields, but also the production of biologically and technologically valuable food, i.e. products (Kastori *et al*., 2013).

Plants optimally provided with potassium consume less water for the synthesis of organic matter and have a lower transpiration coefficient. Plant species with increased requirements for potassium are sugar beets, corn, potatoes, sunflowers, alfalfa, tobacco, buckwheat, spinach, tomatoes and all fruit crops. In case of potassium deficiency, these plants respond positively to potassium fertilization. The potassium needs of these plants are highest in the first half of the growing season, in the phase of intensive growth of vegetative organs. Potassium deficiency most often occurs on sandy, calcareous and clay soils, and the first symptoms appear on the oldest leaves. The lack of potassium affects the tree that becomes shorter and thinner, and the roots shorter and poorly branched with fewer root hairs. Symptoms are in the form of necrosis on the top of leaves and along the edges, and the number of necrotic yellow-brown or brown spots increases gradually, and over time the necrosis covers an increasingly large surface of the leaf, which in extreme cases can lead to premature leaf drop (Varga, 2015). Potassium also acts as a catalyst by regulating a large number of enzymatic activities involved in the growth process and in the transport of nutrients in plants. A high ratio of nitrogen and potassium in soil adversely

affects the yield and quality of crops. Plants sensitive to potassium deficiency are onion and garlic, carrot, potato, sunflower, apple, pear, plum, peach, sour cherry and cherry (Petrović, 2019). The lack of potassium results in slow growth of plants, necrosis along the edges and on the top of the leaves, weaker development of the tree and roots, which all lead to lower quantity and quality of the obtained yield. Too much potassium results in leaf drop and necrosis, and affects optimal absorption of other important elements such as: Ca, Mg, B, Zn and Mn, and leads to increased water consumption, (Glamočlija *et al*., 2015).

Control of fertility of arable agricultural land and consequently giving advice to farmers is carried out by the Agricultural Advisory and Expert Services of the Republic of Serbia, in order to determine the level of nutrients in agricultural land, and ensure the correct use of mineral and organic fertilizers (Janković *et al.*, 2020). Fertility mapping of agricultural soil along with digital sampling records and a software platform for advice on fertilizer use, is the example of science applied for sake of soil conservation and reducing the negative effects of uncontrolled fertilizer application with digital soil sampling records and an electronic database of chemical analyzes and recommendations to farmers on fertilizer use (Janković *et al*., 2021).

The goal of this study was to determine the content of physiologically active potassium in three locations in Serbia in order to ensure the proper use of mineral and organic fertilizers and to preserve the environment and biodiversity.

MATERIAL AND METHODS

Control of the fertility of arable agricultural land in 2020 and consequent giving advice to farmers were carried out by PSSS Smederevo as part of advisory work, in order to determine the level of nutrients in agricultural land, and provide proper advice to farmers. The plots the samples were taken from belong to different cadastral municipalities: Velika Plana, the City of Smederevo and Smederevska Palanka. All plots from which soil samples were taken for potassium content analysis were mapped. When taking samples in the field, the methodology envisages the use of an Android application to record the GPS position of user's mobile device and accompanying data from software created to collect data on soil fertility control. Soil samples were taken in each of the cadastral municipalities of the examined localities, where specialy attantion was paid to the selection of locations and plots so that the samples would represent a real picture of soil fertility in these areas.

The chemical analysis of the samples was carried out in the laboratory of PSSS Smederevo, accredited by the Accreditation Body of Serbia in accordance with SRPS ISO/IEC 17025 standard. The content of easily accessible potassium (K_2O) was determined with the Egner-Riehm Al method (Table 1).

For the purpose of this research, the content of physiologically active potassium (K_2O) in the soil was determined based on the available data from the software on the three investigated localities, along with the mapping of the investigated plots. The average size of the sampled plots for all the localities was

0.90 ha, the maximum 0.98 ha, and the minimum 0.84 ha, which clearly indicates the fragmentation of the plots.

Table 1. Determination of easily accessible potassium content (K2O), Egner-Riehm Al method

Potassium in the soil	Very low	Low	Medium	Optimal	High	Very high	Harmful
K_2O mg/100 g soil	<5.00	5.01-10.0	10.01-15.00	15.01-25.00	25.01-40.00	40.01-50.00	>50.01

The control of the fertility of the agricultural soil was conducted with digital sampling records and a software platform for giving advice to agricultural producers on the use of fertilizers. As part of the field research, soil sampling was carried out by using an android application on a mobile phone with automatic recording of GPS coordinates in the software. The sampling procedure was carried out following a unique methodology, and all of this was accompanied with the necessary documentation in accordance with the standards. The data for these surveys were taken from the software, including data on the sampler, the number and area of the cadastral plot, cadastral municipality and soil class, sampling depth, GPS sampling coordinates, plant, test results, planned yield, recommended amounts of pure nutrients, recommended application of calcareous material, mineral and organic fertilizers, advice on fertilization and soil repair for arable, vegetable and fruit crops for a specific farmer in a specific location.

The laboratory tests included the analysis of the basic chemical properties of agricultural soil: determination of acidity, carbonate content, humus content, total nitrogen, and easily accessible forms of phosphorus and potassium. The results of the research are presented in tabular and graphical form.

RESULTS AND DISCUSSION

In its study, PSSS Smederevo covers three municipalities: Velika Plana, the City of Smederevo and Smederevo Palanka, and in 2020 it carried out fertility control on 1,903 plots and 1,667.54 ha of arable agricultural land. The average area of the sampled plots was 0.90 ha. Table 2 presents the number of the samples by municipality, the total area of the analyzed land and the average size of the plot. The largest number of samples was taken in the territory of the City of Smederevo 996 plots on 830.17 ha, and the smallest number in the territory of the municipality of Velika Plana – 298 plots and 292.53 ha, Table 2, Figure 1.

The optimal potassium content was recorded on 50.7% of the analyzed plots. High (24.5%) and very high content of potassium (5.3%) was recorded on 29.80% of the plots. High (24.5%) and very high potassium content was mostly present in the territory of Velika Plana, on 34% of the analyzed plots. The average content of potassium was recorded on 13.41% and the low content on 1.61% of the analyzed plot, as shown in Graph 2. Very low content of potassium was found on only 0.01%, and harmful content on 4.42% of the analyzed plots,

most of them in the territory of Velika Plana, on 10% of the plots. It is necessary to implement protection measures on these plots against toxicity along with a strict control of both this element and microelements.

Table 2. The number of soil samples by municipality, the total and average size of the plots in the examined localities

No	Municipality	Number of samples	Total area of analyzed land (ha)	Average plot size (ha)
1	Velika Plana	298	292.53	0.98
2	The City of Smederevo	996	830.17	0.84
3	Smederevska Palanka	609	544.84	0.90
Total		1,903	1,667.54	0.90

The content of physiologically active potassium in the soil was analyzed on 1,903 plots and 1,667.54 ha in three different localities that belong to the territory covered by the scope of work of PSSS Smederevo. The obtained results are shown in Table 3 and Figure 1.

Table 3. The content of physiologically active potassium in the studied localities

No	Municipality	Total		The content of physiologically active potassium - K_2O						
		NS*	TA (ha)	H (ha)	VH (ha)	H (ha)	O (ha)	M (ha)	L (ha)	Vl (ha)
1	**Velika Plana**	298	292.53	28.58	22.02	73.44	140.07	24.93	3.49	-
2	**Smeder. – city**	996	830.17	22.29	27.95	219.6	417.65	125.72	16.96	-
3	**Smeder. Palanka**	609	544.84	22.78	39.12	114.89	288.4	72.98	6.43	0.24
Total		1,903	1,667.54	73.65	89.09	407.93	846.12	223.63	26.88	0.24

*NS- No of samples; TA- Total area (ha); H- Harmful (ha); VH- Very High (ha); H- Hight (ha); O- Optimal (ha); M- Medium (ha); L- Low (ha); VL- Very low (Ha)

Potassium plays one of the most important roles in the nutrition of the grapevine, so regular application of high rates of potassium fertilizers is a practice in grape production. Many conditions in the soil can affect the nutrition of the vine with potassium: soil type, clay content, water regime, etc. (Ličina & Marković, 2002). Regarding the time of application of potassium fertilizers in relation to the adsorptive power of soil, such

fertilizers can be applied at any time of the year, because potassium is firmly bound to the adsorptive complex. However, when it comes to reducing adverse effects of chlorine from KCl-fertilizers, they must be applied as early as possible in autumn.

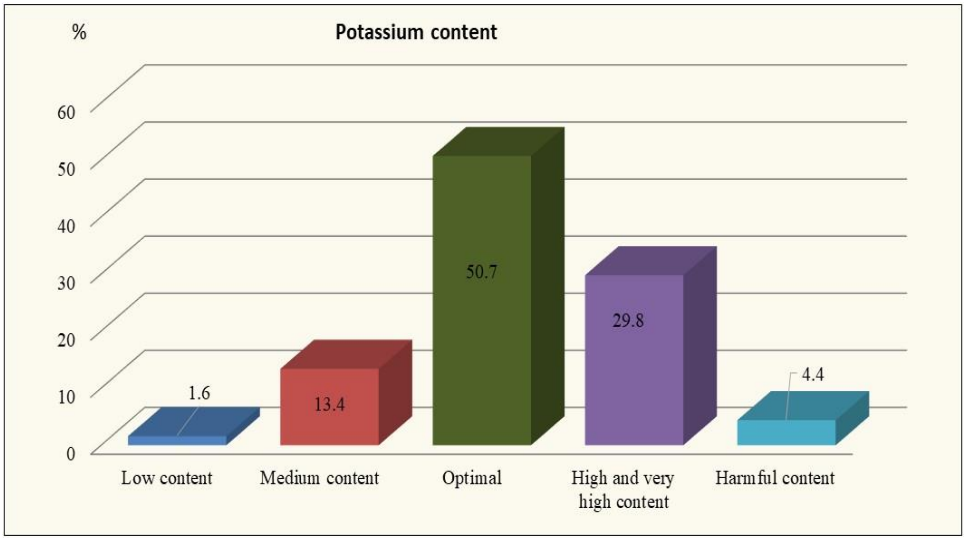

Figure 1. The content of physiologically active potassium (%) in the soil

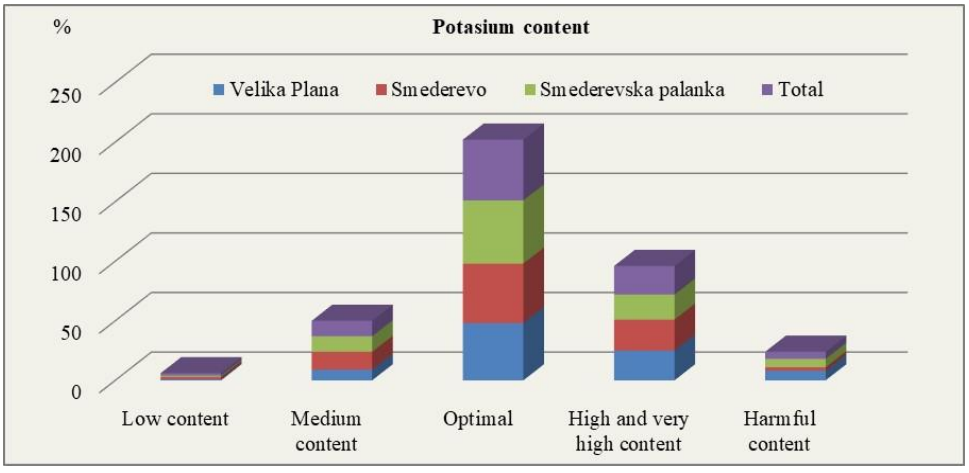

Figure 2. The content of physiologically active potassium in the localities

When applying potassium fertilizers, attention must be paid to the antagonism of potassium to other elements. The antagonism between potassium and Mg, Ca, Na and B is particularly pronounced. When using larger rates of potassium fertilizers, magnesium can be leached out, which is common in lighter, sandy soils. This happens precisely because of the

antagonism between these two elements. The same happens with Ca and Na. Potassium fertilizers also show antagonism towards B. This fact is of particular importance for crops that require both potassium and B, such as sugar beet (Manojlović, 2014).

CONCLUSIONS

Based on the obtained results of soil analyses, the researchers defined and selected arable, vegetable and fruit crops suitable for production on the tested plots, and made recommendations for improving the quality of the soil in the tested areas. On 50.74% of the plots tested for the purpose of this research the optimal potassium content was recorded. High and very high potassium content was found on 29.80% of the investigated plots and the highest content was recorded in the territory of Velika Plana, on 34% of the analyzed plots. Medium content was recorded on 13.41% and low on 1.61% of the analyzed plots. Harmful potassium content was found on 4.42% of the analyzed plots, and the highest values of it were in the territory of Velika Plana, on 10% of the analyzed plots.

Farmers were given proper advice on fertilization and the application of other agrotechnical and amelioration measures on the analyzed plots. Further research should be based on developing more sustainable and natural alternatives, innovations, including technological solutions for sustainable production and precision agriculture.

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