ABUNDANCE OF POTASSIUM AND PHOSPHORUS IN AGRICULTURAL SOIL OF THE MUNICIPALITIES AND THE TOWN OF NIS

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ABSTRACT

Biogenic elements constitute a group of elements necessary for all living organisms. Among them, phosphorus and potassium take an extremely important place. This paper presents the test results of readily available potassium (K_2O) and phosphorus (P_2O_5) contents in the soil of all five municipalities of the town of Nis in 2015. The contents of readily available potassium and phosphorus were tested using the Egner-Riehm method, AL-method. The concentration of available forms of potassium and phosphorus is expressed in P_2O_5 or K_2O $100g^{-1}$. It was found that 63% of the potassium samples belong to a class of soil abundant in potassium, while only 1.6% of the samples belong to a class of soil poor in potassium. The phosphorus content in the soil of Nis shows that 37.7% of the samples belong to a class of soil with medium abundance in phosphorus, 27.8% belong to the soil abundant in phosphorus, and 34. 5% to the soil poor in phosphorus. The medium pH value of the examined territory is 6.48.

Key wods: available, potassium, phosphorus, soil, Nis

INTRODUCTION

Of all the cations, potassium is adopted by plants in the largest quantity. Potassium is not included in the organic compound of the plants, but it does affect a number of vital processes of plants (Kastori et al., 2013). Young plant organs that are growing contain the largest quantities of potassium.

In examining the contents of N, P and K in pear seedlings, in the bark and wood during winter (Šebek et al., 2007), we have found that the level of phosphorus in one-year old seedlings of indigenous varieties affects the resistance of pear seedlings to low temperatures. It has been found that certain pear seedlings had a higher level of potassium in the bark and wood in relation to other seedlings examined, even more than wild pear seedlings, which leads to the conclusion that potassium has an important influence on the resistance to low temperatures.

Apart from the influence of phosphorus and potassium to plants, these elements are also necessary for animals, which receive these two elements through feed. Over 70% of the phosphorus contained in animal feeds of plant origin is in the form of phytic acid and its salts, phytates. Phytic acid is a storage form of phosphorus and energy in many plant species (cereals, legumes, seeds and nuts). However, phytic acid cannot be utilized by monogastric animals (horses, pigs, poultry...), since they create a very small amount of phytase enzymes, so it has to be added to their feed. There is research, according to which, phytic acid is "antinutrient," i.e. it prevents the body from absorbing minerals. This acid is linked to the minerals: zinc (Zn), iron (Fe), manganese (Mn) and calcium (Ca), in this way reducing the amount that is available to the body (Sakač et al., 2007). However, this absorption interference is only temporary, which means feeds rich in phytic acid and its salts should not be avoided. Studies have shown that phytic acid acts as an antioxidant, that it is anti-inflammatory and lowers cholesterol... (Gibson et al. 2010; Schlemmer et al. 2009).

Phytase is an enzyme that improves the digestibility of phosphorus from phytic acid (inositol-6-phosphate). The paper of Grčak T. D. (2015) examines the influence of premixes (vitamin and mineral supplements) that, in addition to other necessary nutrients for egg-laying hens, also contain phytase. It was found that the premix had a positive effect on the quality of table eggs.

Testing the application of phytase in broiler chickens (a breed of chickens for fattening), with the aim to increase the efficiency and reduce the excretion of phosphorus in the environment (Živkov-Baloš et al., 2007) it was found that there was an increase in

utilization of P and Ca (calcium) from feed, i.e. the amount of Ca and P in excretions was reduced. Due to a lack of phytase, phosphorus passes through the digestive system unchanged and is excreted through manure. In this way, it pollutes the environment with non-digestible organic matter in the manure.

MATERIAL AND METHODS

Our analysis of the phosphorus and potassium contents in the soil covered the following municipalities of the town of Nis: Crveni Krst (181.5 km^2), Medijana (16 km^2) Pantelej (141 km^2) Palilula (117.37 km^2) and Niska Banja (141.1 km^2) (Picture 1). The total area, from which 284 phosphorus test samples and 307 potassium test samples were collected, was 597 km^2 (0.7% of the territory of Serbia). The collection and testing of samples was carried out in 2015.

Picture 1. Municipalities of the town of Nis

Slika 1. Opštine grada Niša

The concentration of available forms of phosphorus and potassium in the soil is expressed in mg P_2O_5 or K_2O $100g^{-1}$ of the soil. The measuring of available phosphorus and potassium in the soil was carried out using the Egner-Riehm method, AL-method. For the chemical analysis of potassium and phosphorus, soil samples were triturated in order to be sifted through a sieve of a pore (opening) diameter of 1 mm. The method is based on the extraction of readily available phosphorus and potassium with AL solution. AL solution is composed of: 0.1 N ammonium lactate and 0.4 N glacial acetic acid. From this extract, potassium is determined in a flame photometric way. From the resulting extract, phosphorus is determined colorimetrically, which is done with a spectrophotometer.

The Egner-Riehm method, AL-method, is considered to be more suitable than other methods, because both readily available phosphorus and potassium are determined from the same extract. It is also suitable for the determination of readily available phosphorus in soils with a wide range of pH (Predić, 2011).

RESULTS

In our study, we analyzed 284 samples regarding the amount of available phosphorus and 307 samples regarding the amount of available potassium in the soil. Chemical analyses were conducted in a laboratory of the Agricultural Advisory Professional Service in Nis and the results of the given analyses are shown in Table 1 (Jelić, 2012) and Graph 1.

Phosphorus and potassium in soil

Table 1. Soil classification regarding the readily available potassium and phosphorus supply (Jelić, 2012).

Table 1. Klasifikacija zemljišta u pogledu raspoložive količine kalijuma i fosfora (Jelić, 2012).

Types of soil	Content P_2O_5 (mg $100g^{-1}$soil)	Percent (%) of pitches P_2O_5	Content K_2O (mg $100g^{-1}$soil)	Percent of pitches (%) K_2O
Badly supplied - poor	< 10	34,5	< 10	1,6
Moderate supplied soil	10 - 20	37,7	10 - 20	35,5
Well supplied soil – rich	> 20	27,8	> 20	62,9
Total		100.0		100.0

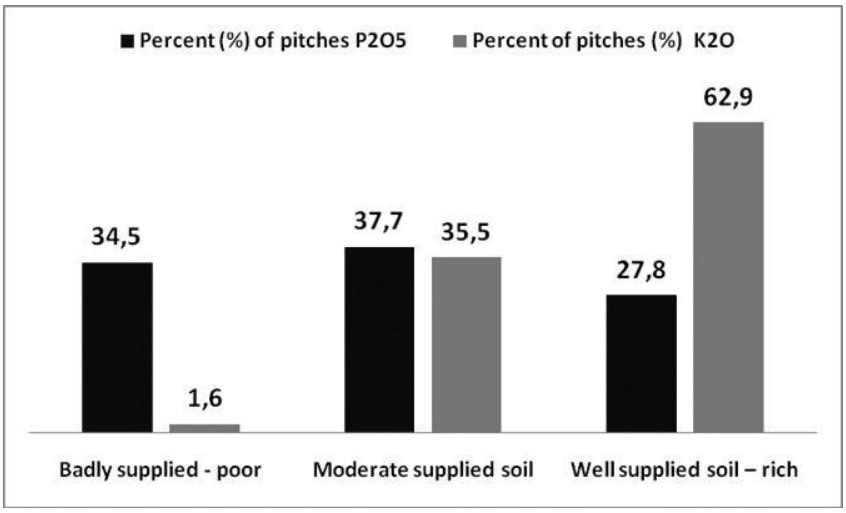

Fig. 1. The percentage of the soil supply with P_2O_5 and K_2O

Graf 1. Procenat snabdevanja zemljištem sa P_2O_5 i K_2O

DISCUSSION

Based on 284 samples of the soil of the municipalities and the town of Nis that were processed for phosphorus, it was found that 34.5% of the analyzed samples belonged to a group of soil poor in available phosphorus (< 10 mg P_2O_5 100g $^{-1}$), while 37.7% of the analyzed samples of agricultural land belonged to the class of soil with medium abundance (10-20 mg P_2O_5 100g $^{-1}$) in available phosphorus.

The analyzed samples in the percentage of 27.8% belonged to the class of soil abundant in readily available phosphorus (over 20 mg P_2O_5 100g $^{-1}$), (Table 1, Graph 1).

In the analysis of potassium, values up to 40 mg K_2O 100g $^{-1}$ of the soil were registered, and all values higher than this were marked as > 41 mg K_2O 100g^{-1} of the soil, and such soils were considered to be extremely rich in readily available potassium.

Based on a large number of studies, our conclusion is that the content of phosphorus in the soil is around 0.02-0.15%. It is the most abundant in a non-organic form of different solubility, and this is why it is necessary to determine the abundance of readily available form of phosphorus P_2O_5 by analyzing the soil. After the end of the plant life cycle, it returns to the soil through organic matter. Acidic soils are poor, while neutral and alkaline soils are rich in readily available phosphorus. An excess of phosphorus in the soil causes the symptoms of Zn, Mn or Fe deficiency, since phosphorus binds these elements. Phosphorus deficiency causes reduced plant growth, where leaves are smaller and fall off prematurely. Phosphorus deficiency causes the synthesis of anthocyanins, where leaves turn purple at the margins and the lower side (on the back). Microorganisms adopt phosphorus to build their bodies, and after their death, phosphorus becomes available to plants. Phosphorus is accumulated in plant fruits. The amount of phosphorus that has left the soil should be returned through fertilizers. The acidic reaction of soil and an insufficient abundance of readily available phosphorus negatively affect the number of microorganisms in the soil. Microbial activity has a strong influence on soil fertility (Bjelić et al., 2015).

The total number of test samples for readily available potassium in the soil of the municipalities of Nis amounted to 307 samples. In terms of percentage, around 62.9% of the samples belonged to the class of soil abundant in readily available potassium (over 20 mg K_2O 100g^{-1}), i.e. 193 samples of the total number of samples (307).

Around 35% of the samples (109 samples) belonged to the class of soil with moderate abundance (10-20 mg K_2O $100g^{-1}$), while we classified only around 1.6% of the tested samples (5 samples) as soils insufficiently abundant in potassium.

The soil samples taken were also analyzed for pH values. The average pH was 6.48. The minimum registered value of pH was 4.20 and the maximum was 7.17. Variability was calculated by means of the standard deviation was ± 0.39, indicating that there were no major differences between the pH values.

Based on many studies, it was found that the amount of potassium in the soil was around 2%, of which a small portion was readily available. Nitrogen (N) is the only element that plants adopt from the soil faster than potassium. These elements are followed by phosphorus, calcium, magnesium... Soils of a heavier texture, with more clay, have more potassium than sandy soils. Potassium affects photosynthesis, synthesis of proteins, transport, construction of carbohydrates, plant resistance to diseases and low temperatures, and the like. On the other hand, potassium deficiency can first be observed on leaves; the tops and margins of leaves turn yellow-green in color and the plant is more vulnerable to diseases.

An uneven application of fertilizers in non-agricultural soil results in a state of excessive content of readily available phosphorus and potassium (Tintor et al., 2015). A high content of phosphorus in soil affects the adoption of zinc (Zn) by plants, due to the antagonism of phosphorus and zinc (Bogdanović and Čabilovski, 2007). The same authors state that soil that has 40-60 mg K_2O $100g^{-1}$, where vegetables are grown, is considered to have sufficient content of potassium.

Chemical properties of soil are very important for the adoption of chemical elements by plants, and the soil reaction (pH) is particularly pointed out. The optimal pH of the environment for the adoption of macroelements is in the range of pH 6-7.5, while the acidic environment of pH 4.5-5.5 suits microelements, with the exception of molybdenum, to which neutral and alkaline environments suit. Different plant species have different requirements for soil pH (Bogdanović et al., 2004).

Humus is a very important factor of soil fertility. Humus soils contain large amounts of biogenic elements. Humic substances bind cations and anions in a form that is easily accessible to plants.

The analysis of soil from the municipality of Aleksinac found that over 55% of the soil belonged to a class of soil abundant in humic substances, having a content of humus from 3% to 5% (Grčak M.D, 2015).

A low phosphorus content in soil is usually solved by applying phosphatization, which is one of meliorative ways to introduce phosphorous fertilizers into the soil. The excess of phosphorus in soil can cause Zn, Fe, Ca, B and Mn deficiencies. It is recommended to omit phosphorus fertilization, and apply deep tillage, since phosphorus is generally immobile in soil, so it is accumulated in topsoil.

CONCLUSION

Starting from the objective of this paper, and on the basis of the results obtained by examining the contents of available phosphorus and potassium in the agricultural soil in the municipalities and the town of Nis, in an area of 597 km², in 2015, the following conclusions can be drawn:

The soil of the municipalities and the town of Nis contained readily available phosphorous, P_2O_5, in the class of medium abundance with 37.7% of the analyzed samples of the agricultural soil. There followed the class of low abundance in readily available phosphorus with 34.5% of the analyzed samples. Finally, 27.8% of the analyzed samples belonged to the class of soil abundant in phosphorus.

As for the content of potassium in the soil of the municipalities and the town of Nis, the largest number of samples, 62.9%, belonged to the class of soil abundant in readily available potassium, while 35.5% of the samples belonged to the class of soil with medium abundance in potassium. Only 1.6% of the examined samples belonged to the class of soil poor in potassium.

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ЗАСТУПЉЕНОСТ КАЛИЈУМА И ФОСФОРА У ПОЉОПРИВРЕДНОМ ЗЕМЉИШТУ ОПШТИНА И ГРАДА НИША

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Biogeni elemenati čine grupu neophodnih elemenata za sve žive organizme. Među njima izuzetno važno mesto zauzimaju fosfor i kalijum. U radu su prikazani rezultati sadržaja lakopristupačnog kalijuma (K_2O) i fosfora (P_2O_5) u zemljištu, svih pet Gradskih opština i grada Niša, tokom 2015.god. Sadržaj lakopristupačnog kalijuma i fosfora ispitani su AL-metodom Egner-Riehm-a. Koncentracija pristupačnog oblika kalijuma i fosfora izražava se u mg P_2O_5 ili K_2O 100g-1. Utvrđeno je da 62,9% uzoraka kalijuma pripada klasi dobro obezbeđenog zemljišta, samo 1.6% uzoraka pripada klasi siromašnih zemljišta kalijumom, ostalih 35.5% uzoraka pripada klasi zemljišta srednje snabdevenog lakopristupačnog kalijuma. Sadržaj fosfora u zemljištu Niša pokazuje da 37.7% uzoraka pripada klasi srednje snabdevenog zemljišta, 27.8% pripada zemljištu bogato fosforom, a 34.5% zemljišta siromašno fosforom. Srednja pH vrednost na ispitivanoj teritoriji je 6.48.

Ključne reči: lakopristupačan, kalijum, fosfor, zemljište, Niš

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