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AGRO-ECOLOGICAL CONDITIONS OF FRUIT GROWING IN THE PEŠTER (PLATEAU) REGION

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Abstract

Pedological and land capability properties of soil in the Pešter plateau region (the Municipality of Tutin, Serbia), indicate that those are predominantly shallow, poorly fertile soils, rated with class 5 and above. By altitude and relief predisposition, agricultural land is extremely mountainous with the average altitude of approx 1000m. Fruit area takes 0.9% of the territory or 340 ha of the area, with plum dominating in the production structure and a tendency of planting raspberry. Analysis of agro-physical and agro-chemical properties of the soil planned for established fruit plantations show that the soils within the same area are significantly different and require different repair measures accordingly. Agro-physical properties indicate the classification of clay to light clay soil, with medium to high interval of cation exchange capacity (T). Degree of soil saturation with adsorbed bases (V%) corresponds to other parameters tested, with the highest values in the Pešter region, in the zone under peat fields from which the peat is utilized for commercial purposes (V 85.14 to 98.57%). Agro-chemical properties of the soil indicate the soil reaction range from acid to slightly acid, non-carbonic at 60-75% of the sampled surface depending on the depth of sampling and culture grown. A high (> 5%) and very high (> 8%) humus content is present in the surface horizon (0-30 cm) in about 75% of the tested surfaces. In most of the sampled localities a very low content of available phosphorus was recorded (<6 mgP_2O_5/100 g of soil) as well as the availability of easily accessible potassium (15-25 mg/100g of soil). For the cultivation of fruit species in these conditions, it is necessary to consider all environmental conditions and then select the type and variety (of the species for cultivation).

Keywords: *Agro-ecological conditions, Pešter plateau, Fruit growing.*

Introduction

Pešter plateau region stretches at an altitude of 900 to 1200 meters and is the highest plateau in the Balkans and one of the largest in Europe. Pešter is well known for its specific microclimate, especially during the winter period. Extreme climatic conditions in certain periods of the year, contributed to the development of extensive livestock production, and the development of fruit production takes place gradually, without any particular impact on the balance of agricultural growth. On the part of the Pester plateau, in the municipality of Tutin, extensive plantations of fruit species are present on a total area of 340 ha, predominant fruit species as plums and apples. Other types of fruit are grown in gardens, sporadically. In recent years, there is a trend of establishing modern plantations of hazelnut and raspberry, and a substantial interest in other types of berries and nuts.

Pedological and land capability properties of soil in the Municipality of Tutin indicate that those are predominantly shallow, poorly fertile soils, rated with class 5 and above. High productive soils account for only 33 km^2 of land, i.e. 4.4%. Due to the high altitude, sub-

mountain and mountain conditions, dry areas on one side and waterlogged areas on the other side, as well as a shallow area, it can be said that the agricultural zoning is limited to a small band of up to 800 m above sea level. It is known that proper land management, good agricultural practices (which includes regular soil fertility control and the implementation of the basic principles of fertilization and agrotechnics) can maintain production capacity of land with minimal effects on the environment (Milivojević *et al.*, 2012). The most important preventive measures in the protection of land from degradation are identification of hazards and finding appropriate solutions to overcome them. To this end, a systematic control of fertility i.e. monitoring of soil quality is proposed. (Sekulić *et al.*, 2005). The variability of climate, as well as incomplete agrotechnics due to insufficient application of fertilizers, significantly affect the availability of nutrients in soil, often reducing their accessibility for the plants (Bogdanović, 2009).

The aim of our research is to determine agrophysical and agrochemical characteristics, in agro-ecological conditions of the part of Pester plateau and the possibility of growing different kinds of fruit species.

Material and Methods

The land is sampled in the fall of 2016, in a rural area of the municipality of Tutin in Serbia. The samples were collected on parcels that are not under orchards (meadows, plough fields, stubble field, fallow land, fodder) and parcels under different types of fruit species, of two depths: 0-30 cm, 30-60 cm. Sampled parcels are marked with GPS coordinates with number of samples in village areas, determined on the basis of arable land and agricultural production, Popis poljoprivrede (2012). Agro-mechanical, physical and chemical analyses included examination of: mechanical aggregate composition of soil by sieving and sedimentation of different mechanical fractions JDPZ (1997), determination of the sum of exchangeable adsorbed alkaline cations (S meq $100g^{-1}$) (method Kappen-a), the determination of hydrolytic soil acidity (H meq $100g^{-1}$), cation exchange capacity (T meq $100g^{-1}$), the level of saturation with adsorbed bases (V%). Agro-chemical characteristics of soil are determined by the following methods: pH of the H_2O and 1 MKCl-in (potentiometrically); humus (by the method of Kotzman); total nitrogen (method according to Kjeldahl); readily accessible phosphorus and potassium (AL method, P_2O_5 - colourimetrically, K_2O – light photometrically).

Results and Discussion

The results of mechanical composition of soil in certain village areas in the Municipality of Tutin are shown in Table 1. At the indicated locations (in villages Velje polje, Detane, Raduša, Gluhavica, Crkvine, Melaje and Leskova) there is a tendency of fruit production development.

Table 1. Mechanical composition of soil, Municipality of Tutin

Settlement	Dubina	Sadržaj mehaničkih frakcija (%)						Klasa zemljišta
		2-0,2	0,2-0,02	0,02-0,002	<0,002	>0,02	<0,02	
		mm						
Vele polje	0-30	3.28	63.72	25.00	8.00	67.00	33.00	Sandy loam
	30-60	0.57	49.63	33.30	16.50	50.20	49.80	Clay loam
Detane	0-30	1.84	63.86	28.00	6.30	65.70	34.30	Sandy loam
	30-60	8.65	42.45	35.10	13.80	51.10	48.90	Loam
Raduša	0-30	3.08	67.72	21.40	7.80	70.80	29.20	Sandy loam

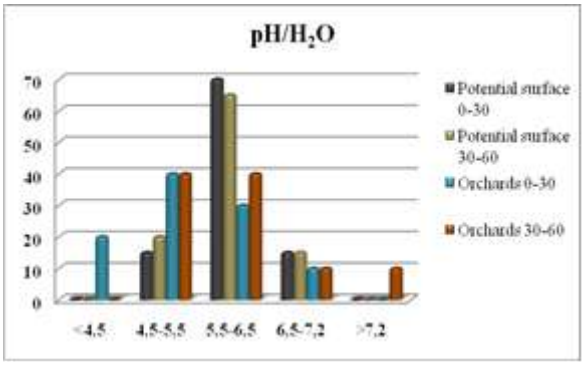
	30-60	0.59	57.61	30.50	11.30	58.20	41.80	Loam
Gluhavica	0-30	2.14	40.56	40.50	16.80	42.70	57.30	Clay loam
	30-60	3.34	31.76	43.79	21.11	35.10	64.90	Clay loam
Melaje	0-30	0.25	35.55	33.00	31.20	35.80	64.20	Light clay
	30-60	2.52	28.38	33.90	35.20	30.90	69.10	Light clay
Leskova	0-30	0.83	52.07	32.10	15.00	52.90	47.10	Clay loam
	30-60	1.18	48.92	31.10	18.80	50.10	49.90	Clay loam
Crkvine	0-30	8.67	40.13	31.00	20.20	48.80	51.20	Clay loam
	30-60	2.13	43.17	30.50	24.20	45.30	54.70	Clay loam

In most of the tested sites, there is a type of clay soil with some differences with respect to the sampling depth. In villages Detane and Velje polje, in the humus Ah horizon (0-30 cm), the fraction share of physical was clay is 33.00-34.30% and 65.70-67.00% is physical sand. In sub humus horizon (30-60 cm) the fraction share of physical clay is increased, with an approximate increase of the powder and clay fraction. Land at the site Raduša is highly humic and by mechanical composition, light to medium loam. In humus (Ah) horizon, they contain 70.80% of physical sand, of which 3.08 % fraction of coarse sand with prevailing powder fraction in relation to the clay fraction. At the site Leskova near the excavation of peat in Gornji Pešter, the land is classified as clay loam with 15.00-18.80% of fraction clay. In villages Gluhavica and Crkvine, in sub humus horizon there comes to an increased content of physical clay with predominant powder fraction with soils of heavier mechanical texture in relation to the former. At the site of Melaje, the highest content of fraction clay (31.20-35.20%) is recorded and with increasing sampling depth, the land in the class of light clays (ISSS classification). According to the American classification, these soils are classified into loamy sand to clay loam. Relatively favourable mechanical composition of the soil for cultivation of different types of fruit species and limited growing conditions indicate that the recommendation for the cultivation of certain fruit species needs to be seen from different angles. The results of research in Table 2 show that the analysed soils have different adsorptive capacity. Analyses show that there is a medium to high cation exchange capacity of the interval (T). Central cation exchange capacity (12-25 meq $100g^{-1}$) at the locality Veljo box Detane, Raduša and Gluhavica, a high capacity in Crkvina and Leskova, while at the site Melaje in humus (Ah) horizon a very high capacity > 40 meq $100g^{-1}$ is present (Kutilek, 1978).

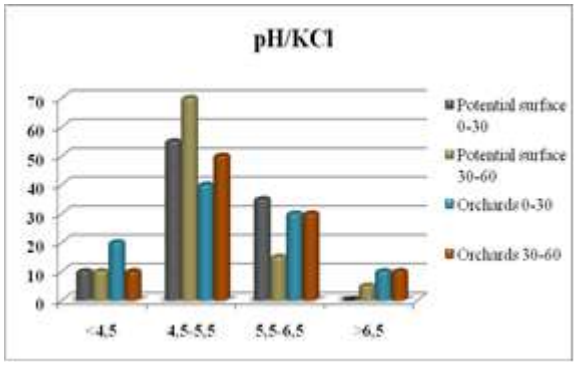
Table 2. Physical and chemical characteristics of soil, Municipality of Tutin

Settlement	Dubina	**S**	**H=T-S**	**T**	**V**
		meq/$100g^{-1}$			%
Vele polje	0-30	6.08	16.02	22.10	27.51
	30-60	3.69	15.05	18.74	19.69
Detane	0-30	8.75	5.06	13.81	63.36
	30-60	5.90	6.63	12.53	47.09
Raduša	0-30	9.04	10.86	19.89	45.45
	30-60	9.64	11.51	21.15	45.58
Gluhavica	0-30	11.9	8.06	19.96	59.62
	30-60	11.36	7.09	18.45	61.57
Melaje	0-30	42.72	0.62	43.34	98.57
	30-60	28.26	3.74	31.99	88.34
Leskova	0-30	25.63	1.55	27.18	94.30
	30-60	25.66	1.43	27.09	94.72
Crkvine	0-30	29.23	5.40	34.33	85.14
	30-60	26.7	4.21	30.91	86.38

Very high levels of hydrolytic acidity, (15.05 to 16.02 meq $100g^{-1}$) and low degree of base saturation (V 19.69-27.51%) were measured in the village Velje polje. In the areas of village Raduša values of hydrolytic acidity are high and average degree of soil saturation with adsorbed bases 50.00-80.00% (Baize, 1993). In Gluhavica, values of investigated parameters are lower. Hydrolytic acidity in villages Detane and Crkvine is 4.21-6.63 meq $100g^{-1}$ and V 47.09-86.38%. At the sites Melaje and Leskova, the measured values are very low hydrolytic acidity and high to very high degree of soil saturation adsorbed bases (V 80.00-100.00%).
Agrochemical characteristics of soils in the Municipality of Tutin are shown in Graph. 1-7.
In the humus (Ah) horizon (0-30 cm), of the soils that are now no longer used for cultivation of fruits (fields, meadows, stubble field, forage crops), 70.0% of the samples belong to the class of weakly acidic reaction (pH/H_2O 5,5- 6.5), and 15.0% of samples each has an acidic (pH 4.5-5.5) or neutral (pH 6.5-7.2) reaction of soil. With increasing the depth of the sampling, in sub humus horizon (30-60 cm), in 20.0% of the samples soil acidity is increased whereas in 65% of the samples soil reaction is slightly acidic. On 30% of sample areas that have been planted with different types of fruit species, the most common are acidic soils (pH 4.5-5.5), then slightly acidic (pH 5.5-6.5), and in humus (Ah) horizon (0 -30 cm) there are also soils with strong acid reaction at two localities (Graph.1).

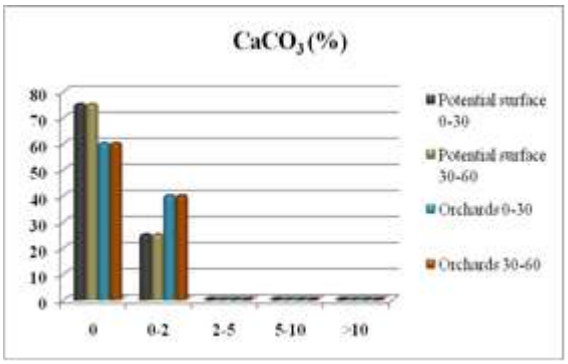


Graph 1. Active acidity of the soil (pH/H_2O)



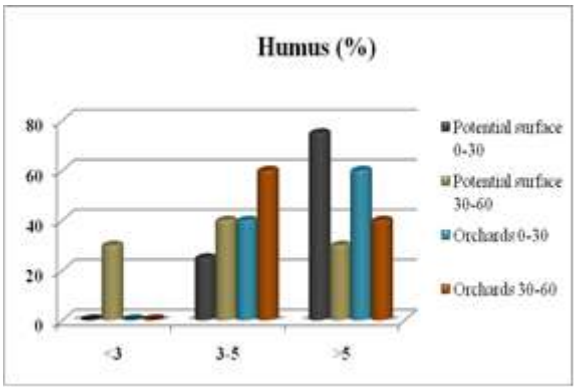
Graph 2. Substitution acidity of the soil(pH/KCl)

Based on the testing results of substitution acidity of soil (Graph. 2), in the humus (Ah) horizon (0-30 cm) of soil which is now not used for the cultivation of fruit trees, 55.0% of the samples has an acidic reaction (pH/KCl 4, 5-5.5) and in the land under orchards 40% of the samples. Weak acid reaction is found in 30-35% of the samples of all tested surface of the first sampling depth. With increasing depth (30-60 cm), an increase of soil acidity happen in the surfaces that are not under orchards to 70.0% and on surfaces under orchards on 50% of the samples in the class of acid reaction. Weakly acidic and weakly alkaline reaction of the sampled soil under orchards is not distinguished by depths of horizons.
Test results (Graph. 3) show that 75% of the samples are carbonate-free (0% CaCO3), and 25% of the samples slightly carbonated ($CaCO_3$ 0-2%) in both sampling depths, on the surfaces that are not under orchards. 60% of the samples on surfaces that are now used for fruit growing are non-carbonated and 40% is slightly carbonated.

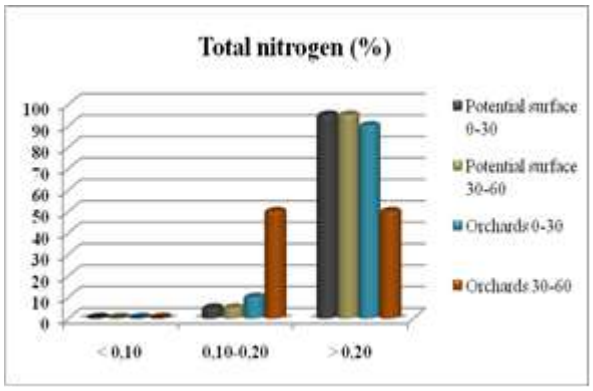


Graph 3. Content of $CaCO_3$ (%)

Based on the testing results of humus content in agricultural soils (Graph. 4), on the surfaces that are not used for fruit cultivation in the humus (Ah) horizon (0-30 cm), 75% of the soil is highly humic and 25% is humic soil. In sub-humic horizon (30-60 cm), there is a reduction of content of humus and the largest percentage of humic (3-5% of humus), 40% of slightly humic (<3% humus) while high humic soils (> 5% humus) are present with 30%. Very high humus content > 8%, is measured in the area of the upper Pester, in the surface horizon of the soil. The surface under various fruit species, depending on the depth of the tested horizon contain from 40-60% of the samples in the class of high humic and highly humic soils.

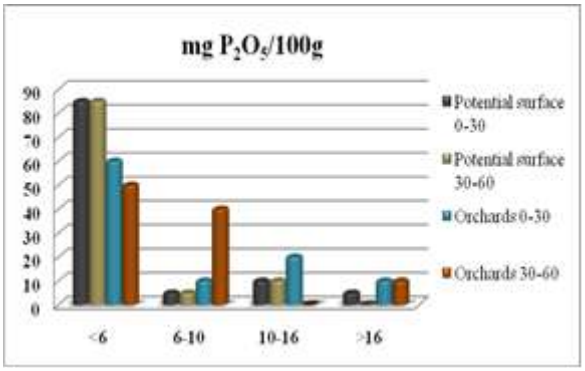


Graph 4. Content of humus (%)

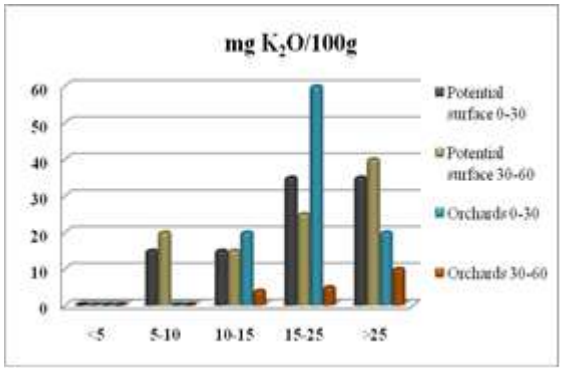


Graph 5. Content of total N (%)

The results of the study shown in Graph. 5 indicate that in the humus (Ah) horizon (0-30 cm) of all tested agricultural areas a high content of total nitrogen in soil (> 0.20%) is found in 90-95% of the samples. Sub humus horizon (30-60 cm) in 95% has a high content of total nitrogen, and in the same soil horizon under orchards, 50% of samples each is with medium and high content of total nitrogen.



Graph 6. Content of easily accessible P_2O_5 (mg $100g^{-1}$ of the soil)



Graph 7. Content of easily accessible K_2O (mg $100g^{-1}$ of the soil)

Soils with reaction pH <6 in 1M KCl in the region of Tutin account for 90%. They have lower content of easily accessible P_2O_5, so that of the samples from potential fruit growing surfaces in both sampling horizon, 75% of them have very low content (<6 mgP_2O_5/100 g soil). Sites of agricultural land under orchards on 50-60% of samples have a very low content of easily accessible phosphorus. The content of easily accessible phosphorus in other threshold value intervals varies in dependence of the sampling depth.

The content of easily accessible potassium (Graph.7), is within the limits of a good supply (K_2O 15-25 mg / 100 g soil). In the humus (Ah) horizon (0-30 cm) of agricultural area which is now not used for fruit cultivation (fields, meadows, stubble, fodder) in 35.0% of the samples show a high content easily accessible potassium, and the same percentage of the samples is in the limits of optimal values, while in the remaining 30% the content is medium to low. Similar results are also obtained with the samples in sub humus horizon (30-60 cm), with minor discrepancies in relation to the volume of overall sample for this Municipality. In the areas under orchards, an optimal content of easily accessible K_2O is found in 50-60% of the tested surface, whereas with a depth horizon increases the medium content of this nutrient.

Soil cover represents an important ecological factor for a successful fruit breeding. While evaluating benefits, that is, fertility of a soil in relation to the respective soil and the properties of the soil itself (Sekulić *et al.,* 2005). Even in the best quality soils created under natural conditions, there may be a limiting factor, which reduces yields, in relation to the genetic potential for a particular plant species (Hađžić *et al.,* 1993; 2002). Based on the investigation results, there is a noticeable heterogeneity of soil cover in different regions of the Municipality. Mechanical composition has a great influence on the water-air, thermal, biological and nutritional regime of the soil (Gajić, 2006). Soils of shallow profile, profile, a low content of clay with low capacity of absorption of cations and acid reaction, have limiting possibilities for the cultivation of certain types. The content of clay fractions of 20-30% enables optimum potential soil fertility, given that other suitable agroecological conditions of fruit cultivation must be met.

Generally, most fruit species are best suited to moderately moist, deep loam-like soils. Certain fruit species require moderate lime soil aerated, moderately moist and deep enough, with slightly acidic reaction and well provided with accessible nutrients.

Conclusion

On the majority of tested sites, in the regions with light clay as the class o soil and certain differences with respect to sampling depth, medium to high interval of cation exchange capacity (T), very high values of hydrolytic acidity, (15.05 to 16.02 meq $100g^{-1}$) and a low degree of base saturation (V 19.69-27.51%) are measured in soils of light clay, where an increase of clay fraction is followed by an increase of the adsorptive capability of soil and degree of base saturation.

In agrochemical terms, active soil acidity on 70.0% of the samples is of slightly acidic reaction and based on substitution soil acidity, acidic reaction is predominant. The field of research shows that 75% of the samples is carbonate-free with the same percentage of highly humic soils. The region of Pester peat areas contains > 8% of humus in the upper horizon. The soil characteristic is a very low content of easily accessible phosphorus (<6 mgP_2O_5 100 g^{-1}). The content of potassium is within the limits of good supply.

Limiting factors for fruit cultivation are climatic conditions, which require the selection of fruit species tolerant to the existing environmental conditions and the application of corrective measures of soil in accordance with cultivated species.

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