CHEMICAL AND GRANULOMETRIC PARAMETERS OF AGRICULTURAL SOIL IN THE *SURČIN AREA - REPUBLIC* OF SERBIA

Aleksandra Stanojković-Sebić, Zoran Dinić, Jelena Maksimović, Darko Jaramaz, Marina Jovković, Radmila Pivić

Institute of Soil Science, Teodora Drajzera 7, 11000 Belgrade, Republic of Serbia
e-mail: astanojkovic@yahoo.com

Abstract

In the period from June to October 2019, tests of chemical properties and granulometric composition of 280 composite soil samples were conducted in the area of Petrovčić and Progar, *Surčin Municipality (Belgrade, Serbia)*, to a depth of 30 cm. The presence of total sand, clay and silt fractions in the analyzed soil samples indicates a relatively uniform granulometric composition (textural class of light clays), but with unfavorable ratio of total sand/clay fractions, in which the clay fraction prevails. The largest number of soil samples has strongly acidic, medium and acidic values of substitution and active acidity, are carbonate-free, while the values of electrical conductivity are very low and indicate the complete absence of salinity in the surface soil horizon/layer. The largest number of soil samples is moderately provided with total nitrogen and humus, with very low, low and medium content of easily available phosphorus, as well as medium (CM Petrovčić) to high and medium provided with easily available potassium (CM Progar). The obtained results indicate that the studied soils of Petrovčić and Progar are suitable for intensive field production. However, low pH values indicate an adequate application of limestone and fertilizers, as well as measures such as undermining and drainage.

Introduction

The municipality of Surčin is the seventeenth municipality of the city of Belgrade (Republic of Serbia). It is located northwest of Belgrade and covers an area of 288 km^2. The municipality of Surčin is mostly characterized by agricultural-processing sector, and then by trade and service activities. The agricultural soil of Surčin covers the territory of two thirds of the total area of the municipality, about 198.16 km^2 [1].

According to Janošević [2], the share of agricultural soil in the municipality of Surčin in 2012 was 20142.5 ha, which is 72.6%. From a pedological point of view, data on the percentage share of certain types of soil indicate that the most common types of soil are fluvisols, as well as saline soils, humogleys and chernozems, which belong to the group of climatogenic (natural) soils, in which formation the climate had a decisive influence. The quality of these soils is very different. The most fertile areas are in Surčin around the airport, while the lower classes are in the settlements of Boljevci, Bečmen, Progar and Petrovčić. The agricultural soil area of the territory of Surčin for the studied areas CM Petrovčić and CM Progar in 2012 was 4091.6 ha. These soils mainly consist of arable soils intended for field production (Table 1).

During the field survey of studied areas it was observed that certain soils, intended for agricultural production, are marginal, in the sense that they have their limitations and are neglected (weedy) [3]. Thus, the position of Surčin itself, which gravitates to the capital city [1], requires the need to try to enable each surface and turn it into a production area.

In addition, one of the main causes of soil degradation in suburban settlements in the municipality of Surčin is the inappropriate application of agro-technical measures (mainly mineral fertilizers and plant protection products). However, the results of previous soil quality studies showed that the pesticides and heavy metals values are below the maximum allowable concentrations [2].

The mixed agriculture market of Surčin is characterized by a relatively high share of large agricultural organizations in the structure of arable soil use, low level of labor investment, high investment of capital, machinery and fertilizers, and high productivity, with a predominance of annual plants [4, 5].

Table 1. Agricultural soil area of Surčin for the studied territories in 2012 [2]

Agricultural soil (ha)		Cadastral municipality (CM)		Total
		Progar	Petrovčić	
Arable	(1) Fields	2277.20	1548.96	3826.17
	(2) Gardens	0.00	0.00	0.00
	(3) Orchards	6.88	2.02	8.90
	(4) Vineyards	3.87	0.63	4.50
	(5) Meadows	28.39	41.02	69.40
	(6) Total (1+2+3+4+5)	2316.35	1592.63	3908.97
Non-arable	(7) Pastures	51.64	0.99	52.63
	(8) Reeds, wetlands	43.84	5.69	49.53
	(9) Other soils	14.02	66.45	80.47
	(10) Total (7+8+9)	109.50	73.13	182.63
Total (6+10)		2425.85	1665.75	4091.60

Based on the mentioned natural conditions and problems of agricultural soil in the municipality of Surčin, the aim of the paper is to examine the condition of these soils through analysis of chemical and physical (granulometric composition) properties, with assessment of growing the crops that would give satisfactory yields.

Experimental

The trial was conducted in the area of Petrovčić and Progar, *Surčin Municipality*, City of Belgrade, Republic of Serbia (grid reference: 44°47' N, 20°16' E). Based on the available satellite images and the pedological map of Institute of Soil Science, scale R=1:50.000, the exact places of observations where sampling was performed were located.

Field work included taking composite soil samples with a probe at pre-determined locations in a disturbed state from a depth of 0-30 cm, according to the instructions, which refer to standard sampling methods [6, 7]. The total number of parcels within the municipality of Surčin, on which a total of 280 soil samples were taken during July and August 2019, was 49 (30 parcels belong to the CM Progar with 155 soil samples, 19 parcels belong to the CM Petrovčić with 125 soil samples). The total study area was 1674.84 ha. Figure 1 shows the position of the sampling point in the area of the Surčin Municipality for CM Progar and CM Petrovčić.

Climate data for a series of 16 observation years (period 2003-2018) were taken from the available meteorological yearbooks of the Republic Hydrometeorological Institute of the Republic of Serbia [8], and processed graphically. Data from the meteorological station Surčin (location: 44°49’ N, 20°17’ E), were used.

The relation between wet and dry periods during 2003-2018 is presented using climate diagram (Figure 2). Diagram shows that the dry period occurs from the end of June and lasts until the last decade of September. This precipitation regime does not positively affect either vegetable or fruit production. Such conditions are most favorable for crop production, since in the period sensitive to drought there is enough precipitation (June), but it is less suitable for winter crops, especially cereals, because the deficit occurs in the period when the plant is sensitive to drought.

The observation of the soil included an adequate sampling from the depth of 0-30 cm and preparation, where the soil samples were air-and, crushed and passed through a sieve with a diameter of ≤2 mm [9], followed by granulometric composition and chemical analyses.

The share of clay, sand and silt fractions in soil (granulometric comosition, respectively), was analyzed by determination of particle size distribution in mineral soil material, using a standardized

method by sieving and sedimentation [10], after which the textural soil class was determined using the International Union of Soil Science (IUSS) texture triangle [11].

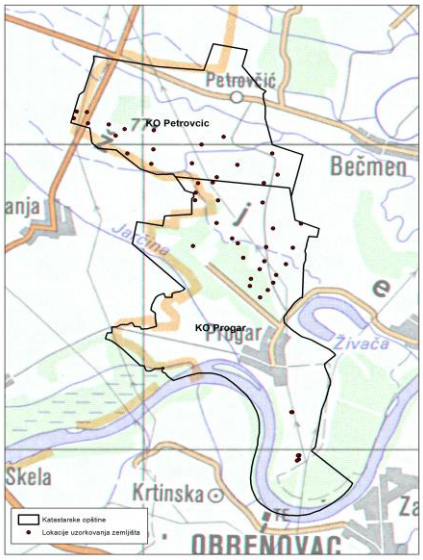

Figure 1. Location of soil sampling points

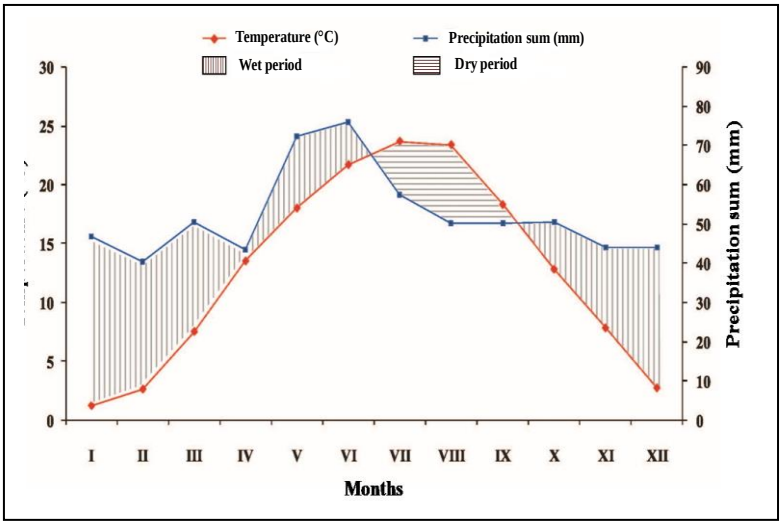

Figure 2. Temperatures and precipitations developments for 16 years of observation (2003-2018) for the studied locality

The following chemical parameters were analyzed: soil acidity (pH in H_2O and 1M KCl, v/v: soil:H_2O=1:5, soil:1M KCl=1:5), potentiometrically, using glass electrode [12]; calcium carbonate ($CaCO_3$), using standard method [13], volumetric; electroconductivity (EC), according to documented method [14], conductometric; available phosphorus (P) and potassium (K), by AL-method according to Egnér-Riehm [15], where K was determined by flame emission photometry and P by spectrophotometer after color development with ammonium molybdate and stannous chloride; total nitrogen content (N), by dry combustion using elemental CNS analyzer Vario EL III [16]; humus content, using Kotzman method [14]. The results are presented in tables and graphs using Microsoft Office Excel 2007 statistical and mathematical program. The following values were calculated: mean (AVR), minimum (MIN), maximum (MAX), distribution and frequency. GIS software was used as a platform for geostatistical data analysis in spatial data processing.

Results and discussion

Table 2 and Figure 3 display the values of soil granulometric and chemical parameters, texture class and soil distribution in Petrovčić (125 samples) and Progar (155 samples).

The presence of total sand, clay and silt fractions in the analyzed soil samples indicates a relatively uniform textural composition. 94-98% of the examined soil samples belong to the textural class of light clays that have an unfavorable ratio of total sand/clay fractions, in which the clay fraction prevails. Since clayey soils retain water, it is often that waterlogging occurs on fairly flat terrain, which is the case in present study. This indicate an adequate application of measures such as undermining and drainage [5]. According to the values of substitution (pH in H_2O) and active (pH in 1MKCl) acidity, the largest number of samples has a strongly acid (<4.5) to acid (4.51-5.50) reaction. It was determined that almost all soil samples (122 and 143) are without $CaCO_3$ (92-98%) and are below the detection levels. This is completely according to the obtained pH values found previously, where low pH values indicate an adequate use of limestone [17]. Similarly, the values of EC are very low and indicate the complete absence of salinity of the surface soil horizon/layer. The supply of total N ranges from 0.12 to 0.20% in 80-85% of samples, and in 2-4% of samples the values of this parameter are from 0.05 to 0.12%.

Table 2. Granulometric composition and chemical properties of the studied area soil samples

Cadastral municipality (CM)	Petrovčić (125 samples)			Progar (155 samples)		
Textural class*	LC, 97%; SC, 2%; SCL, 1%			LC, 94%; HC, 2%; CL, 1%; SL, 1%; SCL, 1%; SC, 1%		
Granulometric and chemical parameters	AVR	MAX	MIN	AVR	MAX	MIN
Sand (%), fraction >0.02 mm	27.8	35.4	12.7	26.7	39.1	14.6
Clay (%), fraction <0.002 mm	35.9	44.7	22.2	36.9	46.5	13.0
Silt (%), fraction 0.02-0.002 mm	36.2	55.5	25.4	36.5	57.7	26.7
pH (1M KCl)	4.78	6.95	3.60	4.74	7.40	3.80
pH (H_2O)	5.71	8.00	4.60	5.80	8.50	4.80
$CaCO_3$ (%)	0.50	0.65	0.43	5.35	14.96	0.65
EC (µS cm)	54.50	366.00	21.20	50.10	175.80	17.60
Available P (mg $100g^{-1}$)	4.81	121.80	0.11	9.60	58.55	0.11
Available K (mg $100g^{-1}$)	20.33	109.50	8.06	25.92	119.54	9.35
Total N (%)	0.18	0.41	0.11	0.15	0.28	0.09
Humus (%)	2.74	4.59	1.44	2.68	6.23	1.35

*LC-Light Clay; HC-Heavy Clay; CL-Clay Loam; SL-Silty Loam; SCL-Silty Clay Loam; SC-Silty Clay

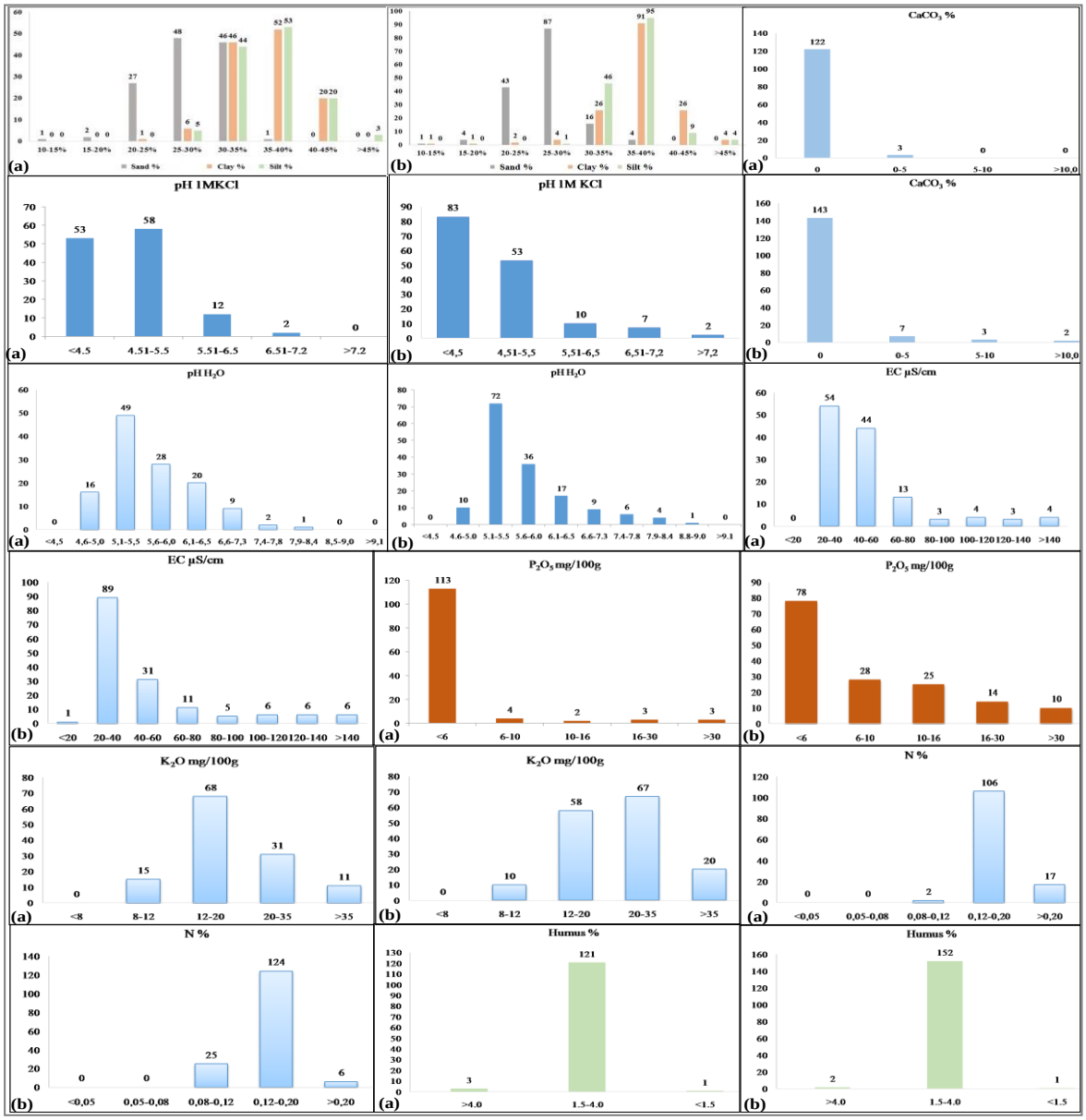

Figure 3. Soil samples distribution according to the study parameters-Petrovčić (a) and Progar (b)

The supply of humus in 97-98% of the samples is in the range of 1.50 to 4.00%, which is a property of slightly clayier soils [17]. The content of easily available P in 91% of samples (113 samples) from the area of Petrovčić is very low, while in the area of Progar 50% of samples (78 samples) have a very low, 18% (28 samples) - low and 16% (25 samples) - medium content of the tested element. The low phosphorus content may be a consequence of its immobilization by binding to aluminum and iron in acid soils, as well calcium in alkaline soils, but also of less fertilization with this element [17, 18]. In the area of Petrovčić, the largest number of samples (68 samples, 54%) is with medium content of easily available potassium, while 25% of samples (31 samples) have high content. Soil samples, taken in the area of Progar, are richer in potassium, so the largest number of samples is highly provided (67 samples, 43%) and medium provided (58 samples, 37%) with available potassium.

Conclusion

Results of granulometric and chemical parameters of the soils and their distribution indicate that the examined soils of Petrovčić and Progar, *Surčin Municipality*, are mostly suitable for intensive field production, especially wheat, corn and sunflower. Nevertheless, low pH, mostly medium and low values of other chemical parameters and clayey soils indicate an adequate application of limestone, fertilizers, as well as measures such as undermining and drainage.

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