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Assessment of the impact of the content of hazardous and harmful substances in soil and irrigation water in the area of Prokuplje in the Republic of Serbia

Radmila Pivić, Aleksandra Stanojković-Sebić, Jelena Maksimović, Magdalena Knežević, Zoran Dinić
Institute of Soil Science, 11000 Belgrade, Serbia
Corresponding author: Radmila Pivić, drradmila@pivic.com

The area of the Municipality of Prokuplje in the Republic of Serbia covers a land area of 75896 ha, of which agricultural land occupies 45083 ha or 60%, forest land 26895 ha or 35%, and infertile land 3918 ha or 5% of the area. In 2019, research was conducted which included the assessment of the properties of agricultural land, namely physical and chemical properties, and the assessment of the quality of irrigation water at 26 selected locations. The content of dangerous and harmful substances in the plant material found at the sampling site has also been examined to obtain health-safe products which will enter the food chain of animals and humans.

The study area has a moderate continental climate with mild transitions between seasons in the valley; and long and cold winters in the mountain area. Considering the differences in natural conditions, primarily relief and climate, the climatic data on MS (meteorological station) Kursumlija and MS Nis were processed. Air temperature and precipitation are climatic elements that have the most dominant influence on the intensity and possibility of performing intensive agricultural production. Climatic elements are conditioned by geographical position, latitude, altitude, relief formations, distance from water resources as well as air currents. From the climate diagram of H. Walter, for series of data processed from these meteorological stations, in which the average monthly values of precipitation and temperature are presented, in the area of MS Kursumlija irrigation as a supplement to precipitation should be carried out during June, July and September. While in August the application of this reclamation measure is necessary. In the area of Nis, the addition of precipitation is needed during June and September, and irrigation is a necessary measure that should be applied in July and August.

According to the culture in the study area, the share of wheat and maize is 11.54% each. The mixture of grasses is present in about 19.30% of agricultural areas. Plum is represented on about 23.08% of agricultural land, the cherry on about 19.23%, raspberry on 7.69%, blackberry and strawberry on 3.85% of agricultural land. Most of the studied localities, in accordance with the texture class, are characterized by low water permeability and low filtration rate, so in accordance with the above, it is desirable to take some of the agrotechnical and agro-ameliorative measures to regulate water-air regime such as deepening the arable horizon. , increases water accumulation and at the same time achieves better permeability to water and air.

The stability of structural aggregates, determined in the surface horizon of the tested profiles, indicates that all tested samples, according to the classification of the degree of stability of micro aggregates according to Vagler, belong to quite stable (19.23%), stable (69.23%) and very stable aggregates (11, 54%). In the examined soil samples, at 25 locations, out of a total of 26 analyzed, the content of total Mn forms was determined above the maximum allowed concentrations (MAC) at both sampling depths (0-30 cm and 30-60 cm). The As content was above the MDK at both sampling depths at only one location. The content of other tested elements: hazardous (As, Cd, Cr, Ni, Pb, Co) and harmful elements (Cu, Zn, Fe) is within the limits of MDK. The appearance of the content of certain elements above the MDK can be part of the geophysical origin and partly of anthropogenic origin so that research into the causes of the occurrence of these concentrations above the permitted values should be investigated in more detail. The content of accessible forms of tested microelements shows that the content of accessible forms of Cu in the tested soils at a depth of 0-30 cm in 88% of the tested samples is very high while in 12% it is high; affordable Fe 96% very high, 4% high; accessible Mn 72% very high, 24% tall, 4% medium; affordable Zn 12% high, 68% medium, 12% low and 8% very low. At a depth of 30-60 cm the content of accessible forms of Cu in 76% of the examined samples is very high, 24% high; affordable Fe 96% very high, 4% high; accessible Mn 64% very high, 32% tall, 4% medium; affordable Zn 4% very high, 40% medium, 48% low and 8% very low.

The obtained values of the tested trace elements in the plant material are low at most of the examined localities so that even on plots with increased content of total forms of tested elements in the soil there are no increased contents in the plant. The exception is the content of the examined trace elements registered at locality number 13, where wheat was sampled. The Pb content above the MDK (Pb = 0.94 mg / kg) was determined in the tested plant material. The results of the research indicate that wheat should not be used in human nutrition, but it can be used for domestic animals. Other tested elements in the mentioned plant material were within the maximum allowed values. Of the 26 tested water samples at the site of soil sampling, according to the FAO classification, 30.76% belongs to the class of drinking water and irrigation, 65.39% to irrigation water and 3.85% primarily to drainage and groundwater.

According to the classification of the US Salynity Laboratory, the tested irrigation water samples belong to: 3.85% class C1-S1 (S1-slightly salty water-low risk of soil salinization) (ECw≤0.250 dSm-1); S1- (SAR 0-10) - water with low sodium content has a low risk of alkalization, suitable for irrigation of all soil types, 34.61% class C2-S1: C2-medium salt water - medium risk of soil salinization (ECw from 0.250 to 0.750 dSm-1), whose characteristics are: moderately saline water, can be used for plants with medium salt tolerance and only if there are conditions for leaching salt from the upper soil layers, relatively permeable soils can be irrigated without special measures to combat salinization, S1- (SAR 0-10) -water with low sodium content has a low risk of alkalization, suitable for irrigation of all soil types, 57.69% class C3-S1: S3-salt water-high risk of soil salinization (ECw from 0.750 to 2.25 dSm), S1- (SAR 0-10) -water is small their sodium content has a low risk of alkalization. Suitable for irrigating all types of land; 3.85% of class C3-S2: S3-salt water-high risk of soil salinization (ECw from 0.750 to 2.25 dSm); S2 - (SAR 11-18) -Water with medium sodium content presents a medium risk of alkalization).

According to the Negebauer classification, the tested water samples can be classified in Ia (30.76%); Ib (34.62%); IIa (11.54%), IIIa (7.69%), IVa (11.54%) IVb (3.85%) class. According to the RSC-Residual Sodium Carbonate classification, 61.54% of the tested samples belong to the class of good waters, 19.23% of the samples to the class of waters at the limit of usability and 19.23% to the samples that are characterized as bad waters. Compared to the Stebler classification, 80.77% of the tested samples belong to the class of good waters, 11.54% of the water of satisfactory quality and 7.69% of the water of unsatisfactory quality. In most of the tested samples of irrigation water, the content of tested microelements and heavy metals is below the MDK (Official Gazette of RS 23/1994), except in the samples at location 12,13,19 where an increased concentration of boron content (V) was found. At location 12, the cause of the phenomenon can be explained in such a way that the water intake is an artificial accumulation-pond in which contamination probably occurred due to careless use of various preparations. Within location 13, where the water is taken from the irrigation system (drop by drop), also the reason for the occurrence of an increased concentration of said element may be the use of fertilizers or other preparations. At location 19, where a water sample was taken from the well, it is necessary to repeat the analysis and determine the reason for the increased concentration of the tested element, and if the reason for contamination is not established, water from this location should be excluded from use.

Based on the obtained results of the content of inorganic pollutants in the soil and plant material, it is possible to define the most favourable areas for growing individual plant species. It is necessary to educate interested agricultural producers who would be given more detailed recommendations on how to take reclamation repair measures and the need for analysis of irrigation water, which would create conditions for the possibility of its use without potentially negative consequences that water of inadequate quality may have inadequate use.

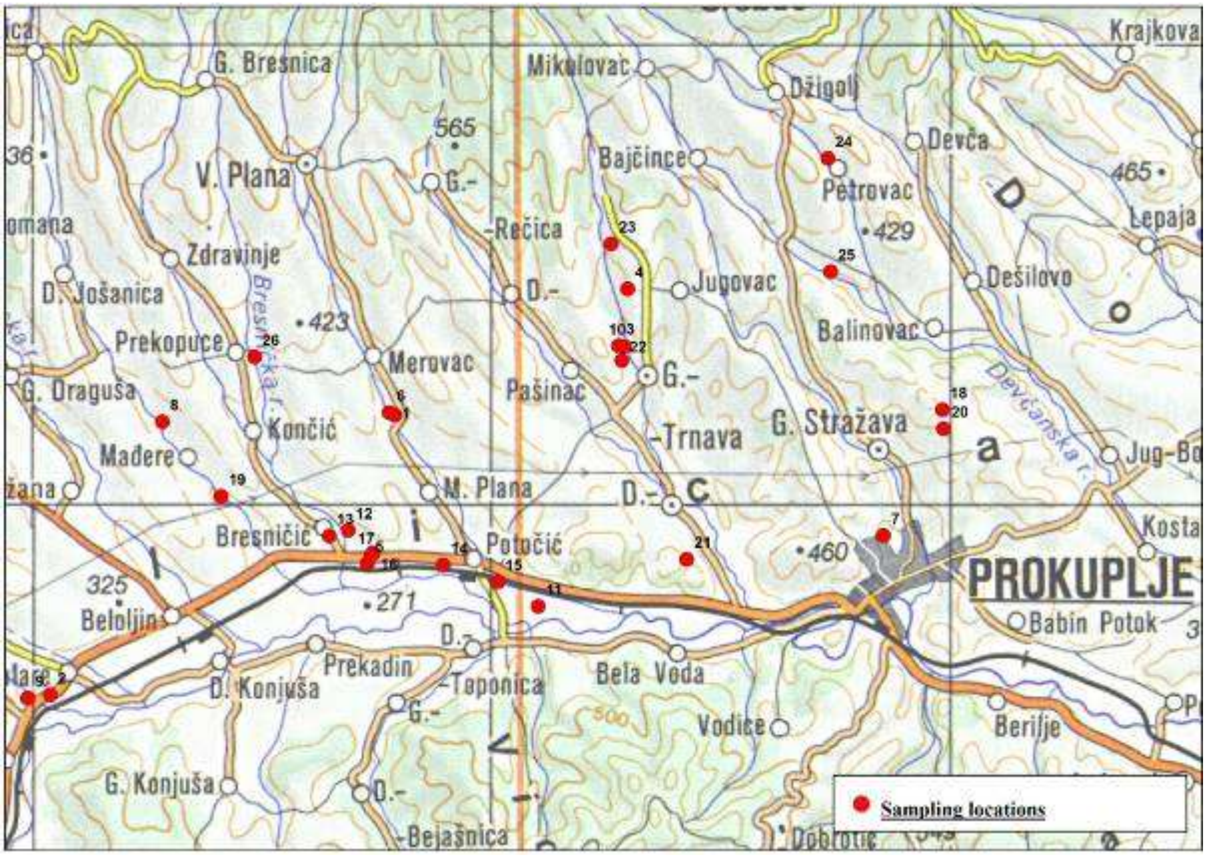

Figure 1.-Sampling sites for soil, plant material and irrigation water (source: Institute of Soil Science, 2019.)

Keywords: Soil, water, plant, irrigation, hazardous and harmful substances

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