XXVI INTERNATIONAL ECO-CONFERENCE® 2022
21–23th SEPTEMBER

XII SAFE FOOD

ЕКОЛОШКИ ПОКРЕТ НОВОГ САДА

PROCEEDINGS

NOVI SAD, SERBIA

XXVI INTERNATIONAL ECO-CONFERENCE® 2022
XII SAFE FOOD
21nd – 23th SEPTEMBER 2022.
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SAFE FOOD

PROCEEDINGS
2022

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Original Scientific paper

THE STRUCTURE OF VERTISOL SOIL IN THE AREA OF THE MUNICIPALITY OF SMEDEREVO

Abstract

The objective of this study was to investigate the structure of Vertisol, the aggregate distribution, and the stability of structural aggregates. The investigation was conducted in the municipality of Smederevo in eastern Serbia. At ten locations, disturbed samples, as well as soil samples for structure analysis were taken. The distribution of aggregates shows the high amount of macro aggregates, low content of aggregates 2-3 mm size, and according to the structural coefficient satisfactory structure. The stability of macroaggregates to dispersion by water in the arable layer of Vertisol is excellent. The results of this research could be used in cultivation practices planning since there is a possibility of improving the structure of Vertisol.

Key words: *Vertisol, soil structure, dry and wet sieving*

INTRODUCTION

The mechanical elements of the soil are connected into structural aggregates of different sizes, shapes, stability, and porosity. Soil structure is the result of the complex interaction between soil's physical, chemical, and biological properties. Of all types of structure, the most favorable is a granular structure with structural aggregates, larger and smaller, that do not have a certain geometric shape, but their rough surface prevents the aggregates from sticking together in a compact mass and such a structure maintains the loose state of the soil. If the topsoil is granular, the water enters easily and seed germination is better (Vučić, 1987). In a prismatic structure, the movement of water in the soil is predominantly vertical and water circulates with difficulty (Brouwer et al., 1985). Soil structure is not permanent and can be improved utilizing cultivation practices.

Vertisol belongs to a group of heavy-textured soils with a high clay content of the montmorillonite type. Vertisol is characterized by phenomena associated with swelling and shrinkage; storage of moisture causes swelling and loss of water causes shrinking. Water-air properties are poor due to the high proportion of capillary and subcapillary pores. The major property contributing to the importance of Vertisols is their high water-holding capacity, but because of the high wilting point, the available water is limited. Because of their low permeability, inadequate irrigation of these soils may result in waterlogging and a buildup of salinity unless adequate artificial drainage is provided. Moderate wetting of these soils provides the best conditions for utilizing the great production potential of Vertisol.

The structure of Vertisol is related to the water regime because of the pressure which results from the swelling and shrinkage processes. Prismatic structural aggregates are a typical feature of the Vertisol structure. Due to the phenomena of self-mulching, a thin loose layer with a granular structure can be created on the surface (Ćirić, 1984)

Therefore, the objective of this study was to investigate the structure of Vertisol, the aggregate distribution, and stability of structural aggregates, and based on the obtained results, to give an agronomic assessment of this soil.

MATERIAL AND METHOD

The surveyed area covers the undulating lowland area of the southern end of the Pannonian basin. It extends near the Danube River. The relief of this area is meso-relief. The altitude of the investigated area ranged from 130 to 259 meters above sea level. The climate belongs to the moderate continental type influenced by the proximity of the Danube River. In the investigated area, the largest part of the land is used for agricultural purposes, and these are mainly orchards of smaller areas.

To determine external and internal soil morphology, at ten locations pedological profiles, pits were opened. From each location, from the arable layer, disturbed samples were taken to analyze the mechanical composition. Also, soil samples were taken to analyze the soil structure according to Bošnjak et al. (2012).

Laboratory analysis

Soil laboratory tests were performed in the Laboratory for Pedology and Soil Water Regime in the Faculty of Agriculture in Novi Sad. The physical and water-physical properties of the soil were analyzed on the samples taken.

The following physical properties of the soil were examined:
– Mechanical composition - determined by the pipette method, and preparation of samples for analysis with Na-pyrophosphate according to Thun,
– Textural class - determined based on Tommerup's classification.

The structure of the soil was examined, that is, the analysis of the aggregate distribution (dry sieving) and the stability of structural aggregates in water (wet sieving).

Dry sieving was determined by the standard procedure according to the Savinov method (Bošnjak et al., 2012). Wet sieving of the soil was performed to determine the stability of the structural aggregates according to the adapted method of Elliott (Elliott, 1986).

The Structure coefficient and Mean weight diameter are used to evaluate the soil structure. The structural coefficient (Ks) is calculated based on the formula (Шеин & Гончаров, 2006):

$$Ks = \frac{a}{b}$$

where a is the content of macro aggregates from 0.25 mm to 10 mm, and b is the content of aggregates smaller than 0.25 and larger than 10 mm.

Mean weight diameter (MWD) was calculated based on the formula (Hillel, 2003):

$$MWD = \sum_{i=1}^{n} x_i w_i$$

where xi is the mean diameter of the class of stable aggregates (μm), and wi is the weight percentage of the class of stable aggregates to the mass of the total sample.

Statistical analysis

The research results were processed statistically by the analysis of variance (ANOVA) method using the TIBCO Statistica 14.0.0.15 software program (TIBCO, 2020). "One-way ANOVA" was used to compare the results of the structural analysis between aggregate fractions. The significance of differences between treatment means was determined by Duncan's test for a significance threshold of 5%.

RESULTS AND DISCUSSION

Mechanical composition

The classification of the International Society of Soil Science is based on the principles of particle division according to Atterberg and is accepted as the basic classification of the mechanical composition of the soil (Belić et al., 2014).

At all locations, soils are classified as loamy clay (data not shown). According to FAO-WRB classification (IUSS Working Group WRB, 2015), the soil belongs to Haplic Vertisol. The surface layer of Vertisol contains from 27 to 44 % of clay. Vertisols may have 30 to 80 percent clay content. The lower limit of swell/shrink activity is approximately less than 35 %. Increasing the content of sand reduces the swelling capacity of the soil (McGarry, 1996).

Soil structural analysis

The soil structure is an indicator of soil fertility. Soils with good soil structure have favorable aeration, water mobility and capacity, heat regime, and root development potential. Poor soil structure increases vulnerability to drought and erosion and can limit the availability of some nutrients (Shepherd, 2000).

Dry sieving

The distribution of soil aggregates, as they exist in the field, is similar to the distribution of fragments only when the energy input is low enough to avoid significant changes in the size of the aggregates (Díaz-Zorita et al., 2002).

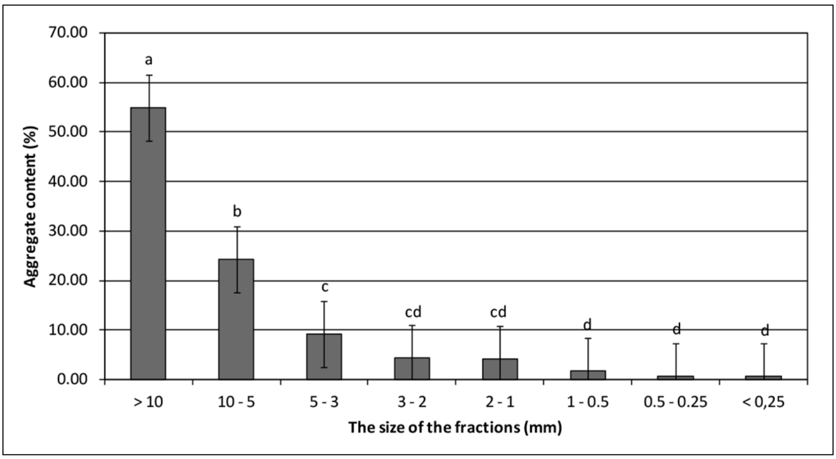

Figure 1. Distribution of structural aggregates of the arable layer of the Vertisol. Vertical lines indicate a standard error and different letters indicate significant differences between aggregate fractions.

The results of dry sieving (Figure 1) show that the arable layer of Vertisol has the highest content of macro aggregates >10 mm in size (54.96 %), and the lowest amount of aggregates smaller than 0.25 mm (4.85%). The total content of aggregates between 0.25 and 10 mm is 44.44 %. Even though from an agronomic point of view the structure cannot be evaluated only by considering the ratio of individual fractions of structural aggregates, the fact remains that aggregates of 0.25-10 mm are the basis for the formation of favorable water-air properties of the soil (Vučić, 1964).

Statistically, significantly higher content of the largest fraction, >10 mm, as well as the aggregate fraction 10-5 mm was determined in relation to the content of the other fractions. Differences in aggregate content of fractions in the range of 1 to 5 mm were not determined, as well as statistically significant differences between fractions smaller than 1 mm. The higher content of smaller aggregates especially aggregates <0.25 mm, indicates a greater dispersion and a greater susceptibility to wind and water erosion.

The investigated Vertisol is characterized by low content of aggregates 2-3 mm in size, about 4,3 % on average, and a high amount of macro aggregates. Vučić (1987) points out that the smallest evaporation is from the soil that has structural aggregates of 2-3 mm size and the highest when the aggregates are 10-15 mm. Also, the rate of water permeability decreases with an increase in the content of dispersed aggregates.

Wet sieving

The results of wet sieving of the soil samples (Figure 2) show that the lowest content of aggregates was in the < 53 µm fraction (12.59 %), and the highest amount of aggregates after wet sieving of the 0-30 cm layer was in the 2000-250 µm fraction (46.41 %). Based on Kačinski's classification, the stability of macroaggregates to dispersion by water in the arable layer of Vertisol is excellent.

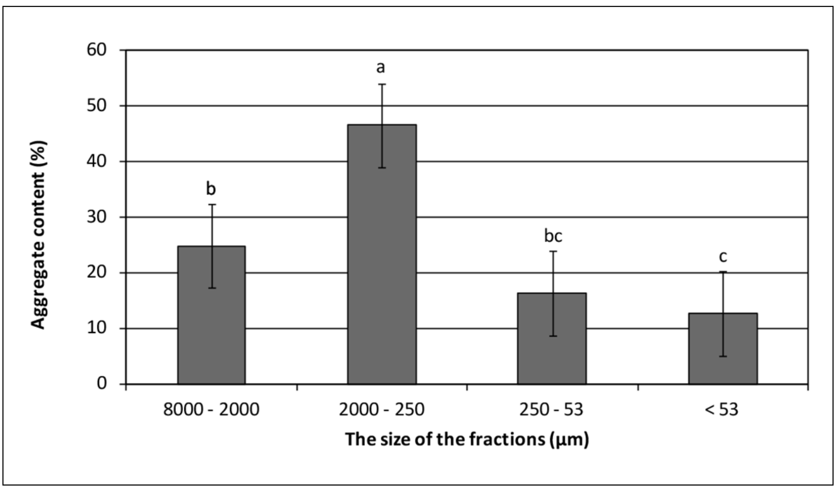

Figure 2. Stability of structural aggregates of the arable layer of the Vertisol. Vertical lines indicate a standard error and different letters indicate significant differences between aggregate fractions.

Statistical analysis revealed significant differences in the content of aggregates between fractions. The analysis indicates significantly higher content of aggregates 2000-250 µm, stable fractions, and significantly lower content of smaller, more unstable fractions of aggregates.

The soil infiltration and filtration, irrigation erosion, the degree of soil compaction, soil crusting, and porosity, that is, the overall fertility of the soil depends on its structure. Soil, especially in irrigation conditions, is exposed to a greater degree of water impact, which can cause unwanted consequences to a certain degree (Bošnjak, 1999). In the conditions of irrigation, land degradation is a consequence of improper exploitation of the irrigation system and the application of poor-quality water.

Structural coefficient and mean weight diameter

If the structure coefficient is greater than 1.5, the soil has a good structure, if it is between 1.5 and 0.67, it is satisfactory, and if it is less than 0.67, the soil has an unsatisfactory structure (Gajic et al., 2014).

The value of the structural coefficient of Vertisol is about 1.00 (Figure 3), that is the obtained results indicate a satisfactory structure of the investigated soils.

Mean weight diameter (MWD) indicates the size distribution of the aggregates and is a measure of the stability of the macroaggregates to water disturbance since the aggregates remaining on each sieve must be stable to the wetting process. The value of the mean weight diameter of the structural aggregates is on average 1.8 for investigated Vertisol soils (Figure 3).

Statistically, the use of any single parameter such as the MWD to characterize a distribution of aggregates is incomplete. Also, the soil with more clay particles gives more undecomposed aggregates, which is not always a sign of a favorable agronomic evaluation of the structure, i.e. a higher coefficient does not necessarily mean a better structure. The importance of assessing the stability of structural aggregates is in monitoring the dynamics and trends in structural changes that are a consequence of land use (Díaz-Zorita et al., 2002; Vučić, 1987).

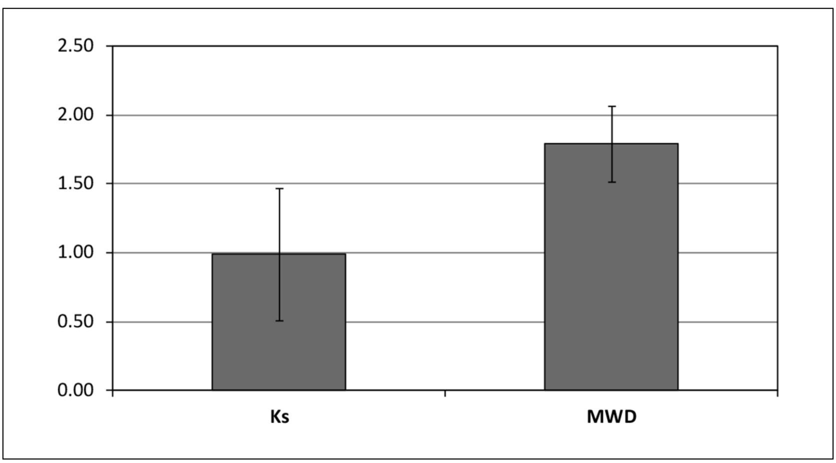

Figure 3. Structure coefficient (Ks) and mean weight diameter (MWD) values. Vertical lines indicate a standard error.

CONCLUSION

The following conclusions can be drawn based on laboratory research of Vertisol soils:

Based on the presence of fractions of mechanical particles, it can be concluded that the examined surface layer of the soil belongs to loamy clay. The surface layer of Vertisol contains from 27 to 44 % of clay.

Based on the results of dry sieving, it can be concluded that the surface layer has the highest content of macro aggregates >10 mm, and the smallest content of aggregates <0.25 mm, responsible for greater dispersion and greater susceptibility to wind and water erosion.

The distribution of aggregates obtained by wet sieving indicates excellent stability of macroaggregates to dispersion by water in the arable layer of Vertisol. Analysis of wet sieving revealed the highest content of aggregates 2000-250 µm, stable fractions, and significantly lower content of unstable fractions of aggregates.

The structural coefficient indicates a satisfactory structure of the tested soils.

The obtained results indicate the possibility of improving the structure of Vertisol and can be used in planning agricultural production.

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Оригинални научни рад

СТРУКТУРА ЗЕМЉИШТА ТИПА СМОНИЦЕ НА ПОДРУЧЈУ ОПШТИНЕ СМЕДЕРЕВО

Резиме

Циљ рада је био да се испита структура смонице, дистрибуција агрегата и стабилност структурних агрегата према расплињавању у води. Истраживање је обављено у општини Смедерево у источној Србији. На десет локација узети су узорци у поремећеном стању и узорци земљишта за анализу структуре. Дистрибуција агрегата показује већу заступљеност макроагрегата, низак садржај агрегата величине 2-3 мм, а према коефицијенту структурности задовољавајућу структуру. Стабилност макроагрегата у обрадивом слоју смонице је одлична. Резултати овог истраживања могу да се користе у планирању пољопривредне производње јер постоји могућност побољшања структуре смонице.

Кључне речи: *смоница, структура земљишта, суво и мокро просејавање*

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