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Original scientific paper

AGGREGATE COMPOSITION AND STABILITY OF STRUCTURAL AGGREGATES IN HUMUS HORIZONS OF FOREST, PASTURE AND ARABLE FIELD RENDZINAS

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The present study includes the results of comparative investigations of aggregate composition and water stability of structural aggregates in humus horizons of calcareous rendzina, Estern Serbia, under native forest and pasture vegetations and the same rendzina utilized long-term as arable field. The results show that aggregate composition and water stability of structural aggregates in the cultivated calcareous rendzina are significantly impaired due to a long-term anthropogenization. In the cultivated rendzina, the content of agronomically most valuable aggregates (0.25–10 mm) is decreased, while the percentage of cloddy aggregates (>10 mm) is increased about 1.5 to 2 times in comparison with the forest and pasture.

The forest and the permanent pasture calcareous rendzina had a greater aggregate water stability than the cultivated rendzina in humus horizon. The lowest water stability is found in aggregates >3 mm.

The largest mean weight diameters (MWD) of dry aggregates were found in forest calcareous rendzina (4.48 mm, vs. 4.23 mm in

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pasture and 3.98 mm in arable field). MWD of water stable agregates was higher in pasture (1.32 mm) and forest (1.12 mm) than in cultivated calcareous rendzina (0.54 mm). The structure coefficient of cultivated calcareous rendzina was lower than in forest and meadow.

Key words: aggregate size distribution, soil aggregate water stability, calcareous rendzina, different land-use managements.

INTRODUCTION

Soil structure is an important property that mediates many soil physical, chemical and biological processes. It is one of the most important indicators of soil physical fertility. According to BRONICH and LAL (2005) soil structure exerts important influences on the edaphic conditions and environment. It determines many physical and biological processes taking place in soil (VAN VEEN and KUIKMAN, 1990). Soil structure and aggregation are strongly influenced by processes such as tillage, croping system and climate (GUERIF *et al*., 2001). Although is most sensitive to tillage (HAMBLIN, 1985), soil structure has a great impact on agricultural productivity and the environment (LAL, 1991). BRONICH and LAL (2005) reported that soil structure can be significantly modified through management practices and environmental changes.

According to SHEPHERD *et al*. (2001) aggregate size and aggregate stability are state indicators of soil structure, and as such, their mean weight percent and mean weight diameters are useful to characterise the effects of increasing duration of conventional cultivation on the quality of the soil tilth.

Soil structure is a very dynamic characteristic, changing through the year in response to tillage as well as to the natural process of drying-wetting, freezing-thawing, earthworm burrowing and root extension. Soil structure degradation is a frequently-encountered phenomenon under intensive arable farming but it is seldom encountered in natural ecosystems (HAYNES and FRANCIS, 1990). ANGERS (1998) reported that soil structure varies in time and space as a function of soil properties, climatic conditions and land management practices.

According to SOROCHKIN (1991), Voronjin considered that, for the estimation of soil structure, most important are the size and form of macroaggregates, their mechanic hardness, water stability and porosity.

From the agronomical point of view, structural aggregates with the diameter of 1-10 mm provide the most favourable conditions for optimal growth of crops (EDWARDS, 1991). Such aggregates should be water stable and should have a good proportion of pores with diameter >75 μm to allow good drainage and aeration during wet annual seasons, and at the same time have an adequate volume of medium size pores (with the diameter 30–0.2 μm) to store available water to plants for dry periods (TISDAL, 1996).

Under the influence of human activity there occurs disaggregation of soil mass, i.e. deformation and destroying of macro- and micro-aggregates, which eventually leads to the degradation of physical soil status (BONDAREV and KUZNETSOVA, 1999). Tillage disrupts soil aggregates and decrease soil organic matter (ELLIOT, 1986; ANGERS *et al*., 1992; LAL, 1993; BEARE *et al*., 1994; PAUSTIAN *et al*., 1997; PLANTE and MCGILL, 2002). According to SIX *et al*. (2000) soil disturbance from tillage is a major cause of organic matter depletion and reduction in the number and stability of soil aggregates when native ecosystems are converted to agriculture.

The quality of soil structure depends on the influence of many factors participating in aggregation, such as humus, clay, carbonates, oxides of iron and aluminium, plant roots, microorganism and earthworm activities (SIX *et al*., 2004; BRONICK and LAL, 2005), microbiological processes (KANDELER and MURER, 1993).

According to AMEZKETA (1999) soil aggregate stability is a crucial soil property affecting soil sustainability and crop production. Soil aggregate stability is a performance quality of soil resulting from integration of many factors related aggregate agents as soil organic matter, clay content, iron and aluminium oxides and root activity (MAPA and ARIYAPALA, 1998). Many investigations have shown that no-tillage improves soil aggregation and aggregate stability (BEARE *et al*., 1994; SIX *et al*., 1999; FILHO *et al*., 2002). After ploughing grassland aggregate stability decreased rapidly and significantly (KANDELER and MURER, 1993; SHEPHERD *et al*., 2001), and increased dry aggregate size (SHEPHERD *et al*., 2001). Stability of structural aggregates and organic carbon content usually decreased with cultivation (FILHO *et al*., 2002; PLANTE and MCGILL, 2002; EYNARD *et al*., 2004b).

The aim of this paper is to estimate and compare aggregate composition and stability of structural aggregates of virgin calcareous rendzina under native forest and pasture vegetations with the calcareous rendzina which has been used for more than 100 years as arable field for agricultural crops production.

MATERIALS AND METHODS

Soil and sampling sites

The investigations were carried out with strongly humose, calcareous stony silty clay loam to clay loam rendzina formed over marl and marly limestone parent material, in the Estern Serbia (44º11'N, 22º48'E). The depth of its humus (Ah) horizon is 20–45 cm.

Field investigations of rendzinas in Estern Serbia, soil sample collection, as well as the determination of some of their most important physical and chemical characteristics has been performed by M. ŽIVKOVIĆ (MILOSAVLJEVIĆ, 1981). For the determination of aggregate composition and stability of structural aggregates in the laboratoty, soil samples have been used from 11 profiles of the humus horizon. Of the mentioned number, 3 profiles represent forest rendzinas, 5 profiles permanent pasture rendzines and 3 profiles long-term arable rendzinas. All the arable fields were usualy ploughed in autumn to a depth of 20–25 cm. The other pedogenetic agents being similar. At the same time, close to the cultivated soil sampling sites, profiles were opened under native forest vegetation, comprised of the community of common *Quercus pubescens, Querces cerris*, and *Quercus conferta* and under pasture vegetation, with abundant participation of *Festuca vallesiaca* and *Andrropogon ischaemum*. The long-term pasture had been under natural grass cover for more than 100 years. Rendzina under native forest vegetation served as the control, i.e. a referent (virgin) soil for investigating of the influence of the mode of agricultural utilization on the changes of its aggregate composition and strucutral aggregate stability.

Analytical methods

Aggregate size distribution

Aggregate size distribution was determined using a dry-sieve method, according to Savinov (DUGALIĆ and GAJIĆ, 2005). Aggregate size distribution was also expresed as the mean weight diameter (MWD). Structure coefficient (Ks) was calculated as the ratio between the content of agronomically most valuable structural aggregates, with the diameter between 0.25–10 mm, and the total content of the aggregates >10 mm and <0.25 mm separated by dry sieving (SHEIN *et al.*, 2001).

Soil aggregate stability

Soil aggregate stability was determined using a wet sieving method, according to Savinov (GAJIĆ, 2005).

Statistical analysis

Statistical analysis of experimental data was accomplished by standard analysis of variance (ANOVA) using the SAS software package (SAS Institute, 2001).

RESULTS AND DISCUSSION

Size distribution of dry aggregates

Mean content of dry structural aggregates of calcareous rendzina under various modes of their utilization is presented in Fig. 1.

The obtained results show that there occurred a significant change in aggregate composition of the cultivated rendzina in comparison with the rendzinas under native forest and meadow vegetations, due to a long-term utilization for crop production, i.e. due to the human activity. Soil degradation is accelerated when perennial crops are converted to row crops, especially due to increased soil disturbance from tillage (KARUNATILAKE and VAN ES, 2002). In the humus horizon all investigated calcareous rendzinas there prevail (>76%), according to MEDVEDEV and CYBULKO (1995), agronomically most valuable fractions of structural aggregates with the diameter between 0.25 and 10 mm. Due to increased compaction, because of threading during tillage, the cultivated calcareous rendzina shows on average significantly (P <0.05) lower (76.3%) content of the agronomically most valuable (by size) aggregates, than the rendzina under meadow

(86.1%) or forest (83.8%). Notwithstanding, on the basis of the contents of these aggregates, and according to the classification cited by SHEIN *et al*. (2001), all investigated calcareous rendzinas is well structured in dry condition. According to MAGDOFF and VAN ES (2000), perennial crops mostly improve soil structure, while annual row cropping often results in structural degradation, mainly due to a loss of ground cover and organic matter losses from soil disturbance.

Due to the application of various agro-technical measures, in the cultivated rendzina total content of cloddy- (>10 mm) and micro- (<0.25 mm) aggregates (23.8%) is about 1.5 to 2 times higher than in the rendzina under pasture (13.8%) and forest (16.2%). COTCHING *et al*. (2002) found significantly higher content of dry aggregates > 9.5 mm in the surface (0–75 mm) layer of cropped paddocks than in the same depth zone of a long-term pasture. Similar observations have been reported by SHEPHERD *et al*. (2001). At intensive soil cultivation, the size of structural aggregates increases as a result of increased clodding (HAKANSSON *et al*., 1988).

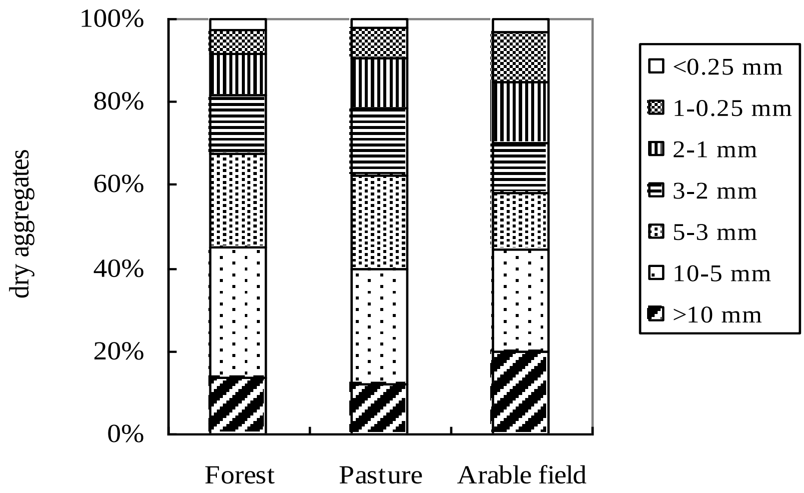

Figure 1. –Effects of different calcareous rendzinas use on dry aggregate size distribution

On the basis of both structure coefficient (Ks) and the mean weight diameter (MWD) of dry aggregates, it may be concluded that the aggregate composition of the cultivated rendzina under a long-term cultivation suffered significant quantitative changes. In the humus horizon of cultivated rendzina Ks (3.21) is about 1.5 to 2 times lower than in the rendzina under forest (Ks = 5.18) and pasture (Ks = 6.21). According to the classification cited by SHEIN *et al*. (2001), Ks values in the all investigated calcareous rendzinas are characteristic for the soils with good structure.

Due to a long-term cultivation, MWD values of dry aggregates in cultivated calcareous rendzinas are significantly ($P < 0.05$) lower (3.98 mm) in comparison with the forest (4.48 mm) and meadow (4.23 mm). SHEPHERD *et al.* (2001) reported similar results. They found that long-term cropping increased MWD of dry aggregate-size distribution. In contrast, COTCHING *et al.* (2002) reported that MWD of dry aggregates, as well as many other physical properties of investigated soils, did not become significantly impaired due to different agricultural management. According to them, one of the reasons was that these soils had not been excessively tilled.

Water stable aggregates

The data presented in Fig. 2 show that under the influence of long-term cultivation there occurred a significant decrease of the water stability of structural aggregates in arable horizons. The long-term cultivated calcareous rendzina had the lowest water stable aggregate (>0.25 mm) percentage of the soil-use systems. Similar results were reported by MARTENS *et al.* (2003). They found that soil aggregate stability was much greater in the forest and pasture soils compared with the cropped soil. According to HOLEPLASS *et al.* (2004) aggregate water stability increased with increasing concentration of soil organic carbon. Cultivation subjects soil aggregates to fragmentation by rapid wetting, raindrop impact and the direct impact of tillage implements, and exposes protected soil organic matter to microbial attack. The consequent decline in soil organic matter reduces the percentage of water stable aggregates (LAL, 1993). The least water stability in the investigated rendzina was found in aggregates >3 mm. Microaggregates exhibit greater stability than macroaggregates (SKJEMSTAD *et al.*, 1990). The content of water stable aggregates >3 mm in the cultivated rendzina (1.46%) is about 27 times lower than in pasture (39.42%), and in comparison with the rendzina under forest vegetation (20.00%) it is lower more than 13 times. The amount of these aggregates in forest is about 2 times lower than in pasture. The percentage of water stable aggregates larger than 2 mm was significantly greater under native savanna than under intervened systems (AMEZQUITA *et al.*, 1998). JANKAUSKAS and JANKAUSKIENE (2003) reported that perennial grasses significantly increased soil aggregate stability. LAFFAN *et al.* (1996) observed that cropping paddocks had significantly lower water stable aggregates than long-term pasture, indicating that these paddocks may be more susceptible to erosion and the effects of raindrop impact when not vegetated. In comparison with plowing no-till management systems have more water stable aggregates and soil organic carbon (FILHO *et al.*, 2002). Similar observations have been reported by PULLEMAN *et al.* (2005). According to them microaggregates from the pasture contained a larger fraction of total soil organic carbon and were more stable than microaggregates from the arable fields.

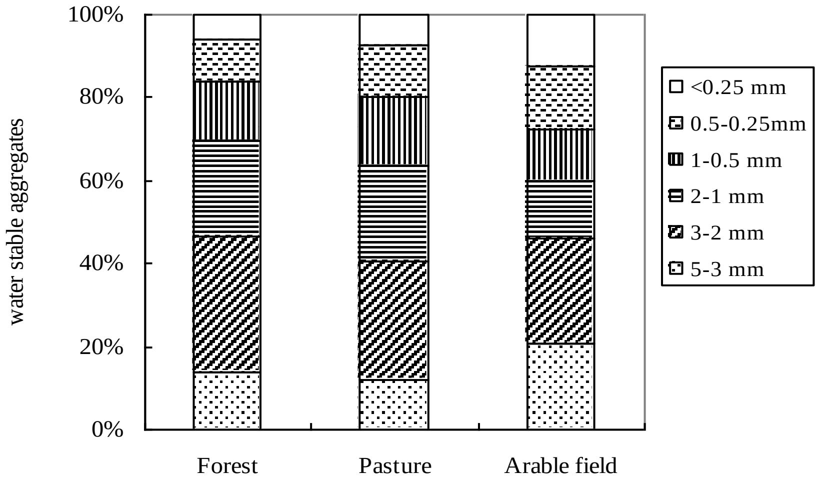

Figure 2. – Effects of different calcareous rendzinas use on size distribution of water stable aggregates

Comparative analysis indicates that under the influence of anthropogenic factors in humus horizon there occurred a significant decrease water stability of microaggregates (< 0.25 mm). The content of these aggregates in cultivated calcareous rendzinas (46.52%) is 2.4 to 3.6 times higher than in rendzinas under forest (19.67%) and pasture (13.25%). MIKHA and RICE (2004) reported that conventional tillage likely enhanced disruption of soil aggregates resulting in loss of soil organic matter.

When pasture soils are brought into cultivation, the stability of soil aggregates and soil organic carbon levels declined rapidly (GOLCHIN *et al*., 1995; FRANCIS, 2001). Higher water stability of structural aggregates in soils under meadow than in cultivated soil was found by KANDELER and MURER (1993), KAVDIR *et al*. (2004) as well as EYNARD *et al*. (2004a). HOYOS and COMERFORD (2005) reported similar results.

Compared the structural aggregate composition of grey forest soils in natural environmental and under long-term cultivation, KOPOSOV *et al*. (1994) observed a drastic decrease of aggregates >0.5 mm, 3–4 times lowering of water stable peds and strong disaggregation of long-term cultivated soils.

Cultivated calcareous rendzinas had significantly (P <0.05) lower MWD of water stable aggregates than forest and pasture. In the humus horizon of forest (1.12 mm) and pasture (1.32 mm) mean values of MWD of water stable aggregates are almost by about 2 to 2.4 times higher than in cultivated (0.54 mm) calcareous rendzina. Average MWD values of water stable aggregates in humus horizon of forest rendzinas are significantly (P <0.05) lower than in the calcareous rendzina under pasture. The decrease in aggregate MWD was mostly due to a decrease in the proportion of water stable aggregates >1 mm. It appeared that macroagregtes of larger sizes are more sensitive to cultivation than smaller sizes when a virgine soil is brought under cultivation (GOLCHIN *et al*., 1995). The conversion of pasture soils to continuous cropping using conventional cultivation markedly decreased the water stability of soil aggregates and increased dry aggregate size (SHEPHERD *et al*., 2001). According to them reductions in total carbon, the loss of the protective coating of glue and web-like structures of organic carbon around the outer surface of soil aggregates under increasing cultivation, were related to the reduction in aggregate stability and increase in dry aggregate size.

CONCLUSION

Comparative study of aggregate composition and water stability of structural aggregates of virgin calcareous rendzina under natural forest and pasture vegetations, with long-term cultivated rendzina, shows that there occurred a significant impairment of the structure and aggregate composition of humus horizon.

The content of cloddy (> 10 mm), poorly porous aggregates in cultivated calcareous rendzina is increased by about 1.5 to 2 times in comparison with the rendzina under natural forest and pasture vegetations. The percentage of agronomically most valuable aggregates (0.25–10 mm) is much decreased in comparison with the rendzina under natural forest and pasture vegetations.

The values of structure coefficient in the cultivated calcareous rendzina are lower than in the rendzina under forest and pasture.

Under the influence of anthropogenization, there occurred a great decrease of structural aggregate water stability. The content of water stable aggregates >3 mm is about 1.5 times lower in the cultivated calcareous rendzina than in the rendzina under forest and pasture.

In the cultivated calcareous rendzinas, the lowest MWD values of dry and water stable aggregates were found, in comparison with the rendzinas under forest and pasture.

REFERENCES

AMEZKETA, E. (1999): Soil aggregate stability: A review. Journal of sustainable Agriculture, 14, 83–151.

AMEZQUITA, E., PRECIADO, G., ARIAS, D.M., FRIESEN, D., SANZ, J.I., THOMAS, R. (1998): Soil physical characteristics under different land use systems and duration on the Colombian savannas. 16th World Congress of Soil Science, 20 – 26 August, Montpellier, France. CD Proceeding, Symposium no: 2, Scientific registration no: 602.

ANGERS, D.A., PESANT, A., VIGNEUX, J. (1992): Early cropping-induced changes in soil aggregation, organic matter, and microbial biomass. Soil Science Society of America Journal, 56, 115–119.

ANGERS, D.A. (1992): Water-stable aggregation of Québec silty clay soils: some factors controlling its dynamic. Soil and Tillage Research, 47, 91–96.

BEARE, M.H., HENDRIX, P.F., COLEMAN, D.C. (1994): Water-stable aggregates and organic matter fractions in conventional and no-tillage soils. Soil Science Society of America Journal, 58**,** 777–786.

BONDAREV, A.G., KUZNETSOVA, I.V. (1999): The degradation on physical properties of soils in Russia and ways to minimize it. Soil Science, 9, 1126–1131.

BRONICK, C.J., LAL, R. (2005): Soil structure and management: a review. Geoderma, 124, 3–22.

CARON, J., KAZ, B.D., PERFECt, E. (1992): Short-term decrease in soil stuctural stability following bromegrass establishment on a clay loam. Soil and Tillage Research, 25, 167–185.

COTCHING, W.E., COOPER, J., SPARROW, L.A., MCCORKELL, B. E. ROWLEY, W. (2002): Effects of agricultural management on dermosols in northern Tasmania. Australian Journal of Soil Research, 40, 65–79.

CHRISTENSEn, B.T. (1992): Physical fractionation of soil and organic matter in primary particle size and density separates. Advances in Soil Science, 20, 1–90.

DUGALIĆ, G., GAJIĆ, B. (2005): Pedologija. Praktikum. Agronomski fakultet, Čačak, 175 pp.

EDWARDS, W.M. (1991): Soil Structure: Processes and Management. In: *Soil* Management for Sustainability. pp. 7–14, Soil and Water Conservation Society, Ankeny, Iowa.

ELLIOTT, E.T. (1986): Aggregate structure and carbon, nitrogen, and phosphours in native and cultivated soils. Soil Science Society of America Journal, 50, 627–633.

EYNARD, A., SCHUMACHER, T.E., LINDSTROM, M.J., MALO, D.D. (2004a): Aggregate Sizes and Stability in Cultivated South Dakota Prairie Ustolls and Usterts. Soil Science Society of America Journal, 68, 1360–1365.

EYNARD, A., SCHUMACHER, T.E., LINDSTROM, M.J., MALO, D.D., KOHL, R. A. (2004b): Wettability of soil aggregates from cultivated and uncultivated Ustolls and Usterts. Australian Journal of Soil Research, 42, 163–170.

FILHO, C.C., LOURENCO, A., GUIMARAES, M.D.F., FONSECA, I.C.B. (2002): Aggregate stability under different soil management systems in a red Latosol in the state of Parana, Brazil. Soil and Tillage Research, 65, 45–51.

FRANCIS, G.S., TABLEY, F.J., WHITE, K.M. (2001): Soil degradation under cropping and its influence on wheat yield on a weakly structured New Zealand silt loam. Australian Journal of Soil Research, 39, 291–305.

GAJIĆ, B. (1998): Comparative investigations of physical properties in various varieties of meadow black soils of the Kolubara valley. Review of Research Work at the Faculty of Agriculture, 43, 25-38.

GAJIĆ, B. (2005): Fizika zemljišta. Praktikum. Poljoprivredni fakultet, Beograd, 185 pp.

GOLCHIN, A., CLARKE, P., OADES, J.M., SKJEMSTAD, J.O. (1995): The effects of cultivation on the composition of organic carbon and structural stability of soils. Australian Journal of Soil Research, 33, 975–993.

GUÉRIF, J., RICHARD, G., DÜRR, C., MACHET, J., RECOUS, S., ROGER-ESTRADE. J. (2001): A review of tillage effects on crop residue management, seedbed conditions, and seedling establishment. Soil and Tillage Research, 61, 13–32.

GÜLSER, C. (2006): Effect of forage cropping treatments on soil structure and relationships with fractal dimension**.** Geoderma, 131, 33–44.

HAKANSSON, I., VOORHEES, W.B., RILEY, H. (1988): Vehicle and wheel factors influencing soil compaction and crop response in different traffic regimes. Soil and Tillage Research, 11, 239–282.

HAMBLIN, A. (1985): The influence of soil structure on water movement, crop root growth, and water uptake. Advances in Agronomy, 38, 95-158.

HAYNES, R.J., FRANCIS, G.S. (1990): Effects of Mixed Cropping Farming Systems on Changes in Soil Properties on the Canterbury Plains. New Zeland Journal of Ecology, 14, 73–82.

HOYOS, N., COMERFORD, N.B. (2005): Land use and landscape effects on aggregate stability and total carbon of andisols from the Colombian Andes. Geoderma, 19, 268–278.

HOLEPLASS, H., SINGH, B.R., LAL, R. (2004): Carbon sequestration in soil aggregates under different crop rotations and nitrogen fertilization in an inceptisol in southeastern Norway. Nutrient Cycling in Agroecosystems, 70, 167–177.

JANKAUSKAS, B., JANKAUSKIENE, G. (2003): Erosion-preventive crop rotations for landscape ecological stability in upland regions of Lithuania. Agriculture Ecosystems and Environment, 95, 129–142.

KANDELER, E, MURER, E. (1993): Aggregate stability and soil microbial processes in a soil with different cultivation. Geoderma, 56, 503–513.

KARUNATILAKE, U.P., van ES, H.M. (2002): Rainfall and tillage effects on soil structure after alfalfa conversion to maize on clay loam soil in New York. Soil and Tillage Research, 67, 135–146.

KAVDIR, Y., ÖZSCAN, H., EKINCI, H., YIGINI, Y. (2004): The influence of clay content, organic carbon and land use types on soil aggregate stability and tensile strength. Turkish Journal of Agriculture and Forestry, 28, 155–162.

KOPOSOV, G.F., SHINKAREV, A.A., PEREPELKINA, Ye.B. (1994): Impact of Land Use on the Grey Forest Soils Structural-Aggregate Composition. Soil Science, 5, 37–41 (in Russian).

LAFFAN, M., GRANT, J., HILL, R. (1996): A method for assessing the erodibility of Tasmanian forest soils. Australian Journal of Soil and Water Conservation, 9. 16–22.

LAL, R. (1991): Soil structure and sustainability. Journal of Sustainable Agriculture, 14, 67-92.

LAL, R. (1993): Tillage effects on soil degradation, soil resilience, soil quality, and sustainability. Soil and Tillage Research, 27, 1–8.

MAGDOFF, F.R., van ES, H.M. (2000): Building Soils for Better Crops. Handbook Series Book 4. Sustainable Agriculture. Network, Beltsville, MD, 224 pp.

MAPA, R.B., ARIYAPALA, D. (1998): Effect of pioneer species on improving soil aggregate stability in a degraded forest land in Sri Lanka. 16th World Congress of Soil Science, 20 – 26 August, Montpellier, France. CD Proceeding, Symposium no: 2, Scientific registration no: 755.

MARTENS, D.A., REEDY, T.E., LEWIS, D.T. (2003): Soil organic carbon content and composition of 130-year crop, pasture and forest land-use managements. Global Change Biology, 10, 65–78.

MEDVEDEV, V.V., CYBULKO, W.G. (1995): Soil criteria for assessing the maximum permissible ground pressure of agricultural vehicles on Chernozem soils. Soil and Tillage Research, 36, 153–164.

MIKHA, M.M., RICE, C.W. (2004): Tillage and Manure Effects on Soil and Aggregate-Associated Carbon and Nitrogen. Soil Science Society of America Journal, 68, 809–816.

MILOSAVLJEVIĆ, M. (1981) rukovodilac projekta: Glavni projekat za podizanje i eksploataciju vinograda “Krajinski vinogradi” i “Bukovsko zlatno brdo” Negotin sa navodnjavanjem i odvodnjavanjem. Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd, pp. 584.

PAUSTIAN, K., COLLINS, H.P., PAUL, E.A. (1997): Management controls on soil carbon. In: Soil organic matter in temperate agroecosystems: Long-term experiments in North America. (eds. Paul EA *et al*.), pp. 15–49. CRC Press, Boca Raton, FL.

PICCOLO, A., PIETRAMELLARA, G,. MBAGWU, J.S.C. (1997): Use of humic substances as soil conditioners to increase aggregate stability. Geoderma, 75, 267–277.

PLANTE, A.F., MCGILL, W.B. (2002): Soil aggregate dynamics and the retention of organic matter in laboratory-incubated soil with differing simulated tillage frequencies. Soil and Tillage Research, 66, 79–92.

PULLEMAN, M.M., SIX, J., VAN BREEMEN, N., JONGMANS, A.G. (2005): Soil organic matter distribution and microaggregate characteristics as affected by agricultural management and earthworm activity. European Journal of Soil Science, 56, 453–467.

ROWELL, D.L. (1997): Bodenkunde.Untersuchungsmethoden und ihre Anwendungen. Springer, Berlin, 614 pp.

SAS Institute 2001. SAS/STAT System for personal computers, release 8.02. SAS Institute, Inc., Cary. NC.

SHEIN, YE.V., ARHANGEL'SKAYA, T.A., GONCHAROV, V.M.,GUBER, A.K, POCHATKOVA, T.N., SIDOROVA, M.A., SMAGIN, A.V., UMAROVA, A.B. (2001): Polevye i laboratornye metody issledovanija fizicheskih svoystv i rezimov pochv. Izdatels'tvo Moskovskogo universiteta. 199 pp.

SHEPHERD, T.G., SAGGAR, S., NEWMAN, R.H., ROSS, C.W., DANDO, J.L. (2001): Tilage-induced changes to soil structure and organic carbon fractions in New Zealand soils. Australian Journal of Soil Research, 39, 465–489.

SIX, J., ELLIOTT, E.T., PAUSTIAN, K. (1999): Aggregate and soil organic matter dynamics under conventional and no-tillage systems. Soil Science Society of America Journal, 63, 1350–1358.

SIX, J., ELLIOTT, E.T., PAUSTIAN, K. (2000): Soil macroaggregate turnover and microaggregate formation: A mehanism for C sequestration under no-tillage agriculture. Soil Biology and Biochemistry, 32, 2099–2103.

SIX, J., BOSSUYT, H., DEGRYZE, S., DENEF, K. (2004): A history of research on the link between (micro)aggregates, soil biota, and soil organic matter dynamics. Soil and Tillage Research, 79, 7–31.

SKJEMSTAD, J.O., LE FEUVRE, R.P., PREBBLE, R.E. (1990): Turnover of soil organic matter under pasture as determined by ^{13}C natural abundance. Australian Journal of Soil Research, 28, 267–276.

ŠKORIĆ, A., FILIPOVSKI, G., ĆIRIĆ, M. (1985): Classification of Yugoslav Soils. Academy of sciences and arts of Bosnia and Hercegovina, Special Publications, Tome LXXXVIII, Department of natural and mathematical sciences, Issue 13, Interacademic committee for soil research, Sarajevo, 72 pp.

SOROCHKIN, V.M. (1991): On the question how to choose indices for agronomical evaluation of the soil structure. Soil Science, 7, 50–58 (in Russian).

TISDAL, J.M. (1996): Formation of soil aggregates and accumulation of soil organic matter. In: Structure and organic matter storage in agricultural soils. (eds Carter MR, Stewart BA), pp. 57–97. Advances in Soil Science.

van VEEN, J.A., KUIKMAN, P.J. (1990) Soil structural aspects of decomposition of organic matter by microorganisms. Biogeochemistry, 11, 213–223.

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AGREGATNI SASTAV I STABILNOST STRUKTURNIH AGREGATA U HUMUSNOM HORIZONTU ŠUMSKIH, PAŠNJAČKIH I NJIVSKIH RENDZINA

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I z v o d

U ovom radu je izvršeno uporedno istraživanje agregatnog sastava i vodootpornosti strukturnih agregata u humusnom horizontu karbonatnih, skeletno praškasto-glinovito ilovastih do glinovito ilovastih rendzina na laporcu i laporovitim krečnjacima, pod prirodnom šumskom i pašnjačkom vegetacijom, i istih rendzina koje se dugotrajno (stolećima) koriste kao njivska zemljišta u istočnoj Srbiji. Rezulteti istraživanja pokazuju da su agregatni sastav i vodootpornost strukturnih agregata u humusnom, tj. oraničnom horizontu njivskih rendzina znatno pogoršani usled dugotrajne antropogenizacije. Međutim, i pored toga, prema klasifikaciji koju navode ŠEIN *et al.* (2001), njihov agregatni sastav je još uvek dobar. U njivskim rendzinama sadržaj agronomski najpovoljnijih agregata (prečnika 0.25–10 mm) je znatno smanjen, dok je udeo (prosek 20.55%) grudvastih agregata (prečnika >10 mm) povećan za 1.5 do 2 puta u poređenju sa šumom (13.49%) i pašnjakom (11.84%). U humusnom horizontu istraženih karbonatnih rendzina pod šumom i pašnjakom utvrđena je znatno veća vodootpornost strukturnih agregata nego u njivskoj rendzini. Najmanju vodootpornost pokazali su strukturni agregati prečnika >3 mm.

Najveći prosečni prečnik strukturnih agregata (MWD) u suvom stanju utvrđen je u zemljištu pod šumom (4.48 mm), 4.23 mm pod pašnjakom i 3.98 mm u njivskoj rendzini. MWD vodootpornih strukturnih agregata veći je za oko 2 puta u zemljištu pod pašnjakom (1.32 mm) i pod šumom (1.12 mm) nego u njivskoj (0.54 mm) karbonatnoj rendzini. Koeficijent strukturnosti u njivskoj redndzini znatno je manji nego pod šumom i pašnjakom.

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