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IMPACT OF DIFFERENT SOIL WORKS AGRICULTURAL TECHNOLOGIES ON SOIL CHARACTERISTICS IN AFUMAȚI, DOLJ COUNTY, PEDOCLIMATIC CONDITIONS

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Abstract

The paper presents the results of physical and chemical analysis of the Calcic Chernozem, in pedoclimatic conditions at Afumați, Dolj county (Romania), farmed in two soil works agricultural technologies: conventional (classical) and conservative (no-till). Two main soil profiles have been worked out and characterized from the morphological point of view and the physical and chemical characteristics, according to the ICPA Bucharest Working Methodology. Soil samples were collected by the 5-10 cm; 25-30 cm and 45-50 cm depths. The analyses and determinations carried out are in accordance with the standardized methodology usually used in the ICPA Bucharest laboratories and those of the County Offices for Pedological and Agrochemical Studies. In both soil works technologies the water infiltration rate is very high so there is no risk of water stagnation; this is also due to the low clay content. No-till technology no longer mobilized calcium carbonate ($CaCO_3$) from the soil profile depth as compared to the classical technology that mobilizes calcium carbonate through deep soil works. No-till technology is ideal for the studied soil in the 2023-2024 agricultural year conditions.

***Key words**: aridification, No-till, soil characteristics, management systems*

INTRODUCTION

In areas with dry climates intensive soil works and removal of plant debris contribute to soil water loss, thus intensifying the processes of drought, aridification and implicitly desertification (Burtan et al., 2023). In recent decades, there has been much research into the analysis of the relationship between climate aridity and land degradation, as well as their contribution to desertification from the perspective of climate change.

Once plant residues increase water infiltration into the soil and reduce evaporation, more water is available to plants in Conservative Agriculture (CA). This reduces the frequency and severity of drought situations and as a result production is also high in dry years too, with a reduced risk of plant loss. For a period of time, with increasing organic matter content, the amount of water that can be retained increases, further reducing the risk of drought (Rurac, 2020). The application of the direct sowing system (No-till) increases the water supply in the soil by reducing the evaporation of water and increasing the microporous space, thus decreasing the requirements for irrigation in dry climates. Currently, it is admitted that the greatest influence in climate change is the increase in the atmosphere carbon dioxide (CO_2) (Rusu et al., 2011).

Conservative agriculture (CA) leads to greenhouse gas emissions abatement by decreasing energy consumption and improving the efficiency of nutrient utilization. At the same time, it stabilizes and protects the soil from decay and the release of carbon into the atmosphere (Rurac et al., 2020).

The no-till system acts as a pool for storing CO_2 and CA applied on a global scale could significantly contribute to the control of air pollution in general and global warming in particular (Gonzales-Sanchez et al., 2011).

No-till can alter soil moisture and temperature conditions (McConkey et al., 1996), aggregate formation, the nutrient cycle (Cookson et al., 2008; Triplett, 2008) and finally plant growth (Helgason et al. 2010). Soil properties as influenced by the tillage system are important indices for soil fertility preservation and the agricultural system sustainability assessment (Gus, 1997; Rusu, 2001; Mark et al., 2004; Jităreanu et al., 2006; Almagro, 2017; Biddoccu et al., 2017; Martinez-Mena et al. 2020, 2021).

Soil tillage system choice must take into account the area pedo-climatic conditions and the crop plant so as to ensure obtaining high good quality yields and with an increased economic efficiency (Guș, 2011; Jităreanu, 2008; Marin, 2012; Rusu, 2009).

MATERIALS AND METHODS

Two systems of soil works were experimented: conventional (classical) and conservative (no-till) in Afumați, Dolj county (Romania), latitude: N: 4400637, longitude: E: 02342667.

1) Pedoclimatic characterization of the studied area

The village of Afumați is located in the southern part of Romania, 20 km north of the Danube, in Băileștilor Plain, part of the Oltenia Plain.

The climate is moderate continental, with a weak mediterranean influence. It is characterized by: hot summers with average temperatures of the warmest month around 23˚C and with a large number of days of tropical character (temperatures above 30˚C). The rainfall conditions in the southern part of Oltenia can be characterized by great variations from one year to another.

Lately moisture shortage has been recorded, especially in July-October, which varied from one year to the next.

Natural forest steppe vegetation is to be met in this territory, rare specimens of *Quercus pedunculiflora* and *Pyrus pyraster*, former components of the forests of the old forest steppe. Weeds such as: *Sorghum halepense*, *Setaria viridis*, *Cynodon dactylon*, *Echinochloa crus galli* have a particularly important role in diminishing agricultural productions through their existence and competition with cultivated plants.

From the pedological point of view associations are to be met in the Băileștilor Plain of Calcic, Calcaro-calcic, Haplic, and Luvic Chernozems, and Haplic, Calcaric, and Luvic Phaeozems (WRB-SR 2014); Haplic Chernozem is the representative type.

The land was prepared in conservative system (No-till) through a single pass, for corn crop in non-irrigated field.

Plowing was carried out in the classical system of soil works with the plow, down to 18-20 cm depth; also discing using the heavy disc harrow, in combination with the star harrow, and roller; sown with the classic seeder, wheat crop, in non-irrigated field.

2) Soil sampling

Two main soil profiles have been worked out and characterized from the morphological point of view and that of the physical and chemical characteristics, according to the Working Methodology of ICPA Bucharest (MESP, vol. I-III, 1987). Soil samples were collected on the 5-10; 25-30, and 45-50 cm depths. The analyses and determinations carried out are in accordance with the standardized methodology usually used in the ICPA Bucharest laboratories and those of the County Offices for Pedological and Agrochemical Studies.

Physical analysis:

Particle-size distribution was done by the pipette method for fractions smaller or equal to 0,02 mm; wet and dry sieving method was used for fractions and subfractions included in the 2-0,02 mm range.

Chemical analysis: pH, nitrogen, phosphorus, potassium, sum of exchangeable bases, hydrolytic acidity, base saturation degree (V, %), calcium carbonate ($CaCO_3$).

pH was determined by potentiometric analysis, using a combined glass and calomel electrode linked to a Delta 340 type Mettler potentiometer (ICPA Methodology, 1986, Chapter 3, and SR 7184/13-2001); organic carbon was measured titrimetric by the Walkley – Black method modified by Gogoaşă (ICPA Methodology, 1981, Vol.1, Part I, Chapter 8, and STAS 7184/21-82); total nitrogen was determined by the Kjeldahl method using Gerhardt, Tecator, and Schott automated devices for digestion, steam distillation, and titration (ICPA Methodology, 1981, Vol.1, Part. I, Chapter 10, and STAS 7184/2-85); mobile forms of phosphorus and potassium soluble in the ammonium acetate-lactate solution (AL) at pH 3.7 were determined by UV-VIS spectrometry (phosphorus) and flame photometry (potassium) (ICPA Methodology, 1981, Vol.1, Chapters 11 and 12, STAS 7184/19-82). Total soluble salts content was determined by conductometric analysis in 1:5 aqueous solution. Cationic exchange properties: the sum of bases (SB) was determined by the Kappen method (ICPA Methodology, 1981, Vol.1, Chapter 2, STAS 7184/12-88) and hydrolytic acidity (Ah) by extraction with a 1 *n* sodium acetate solution, pH 8.3. 1:2.5 soil:solution ratio (ICPA Methodology, 1981, Vol.1, Chapter 2, STAS 7184/12-88).

RESULTS AND DISCUSSIONS

The collected soil samples structure is medium sandy loam. The bulk density (Dawi g/cm^3) is very low in both soil works systems at the 5-10 cm depth (1.23 g/cm^3 conventional and 1.20 g/cm^3 no-till). At 25-30 and 45-50 cm depths in the conventional system it is small, with 1.32 and 1.30 g/cm^3 values, while in no-till system it is also small at 25-30 cm, with a 1.27 g/cm^3 value, and medium at 45-50 cm (1.43 g/cm^3). We can conclude that the bulk density is small due to the small content of physical clay (0.002 mm).

The resistance to penetration (RP, kgf/cm^2) in the conventional experimental field is low at all three soil sampling depths, with values of 16; 22 and 25 kgf/cm^2. In the no-till system the resistance to penetration is very small, with a 8 kgf/cm^2 value at 5-10 cm, small (14 kgf/cm^2) at 25-30 cm, and medium (32 kgf /cm^2) at the last depth.

It can be said that plant roots growth is normal in both the no-till and conventional systems.

The shrinkage index (IC) is an important indicator that defines the degree or level of susceptibility to cracking. It is unsusceptible in the no-till system, with 0.0076, 0.0071, and 0.0042 values for the three soil samples collecting depths, while in the conventional system it is unsusceptible (0.0081-0.0091 values) at the first two depths (5-10 and 25-30 cm) and moderately susceptible (45-50 cm) in the third. So, one can say that the application of no-till technology is beneficial on this type of soil as compared to the conventional (classical) technology.

Water permeability (ksat mm/h) is very high in the experimental field where conventional technology was applied in the upper soil samples collecting layer, with a 37.37 mm/h value, and high (17.70-29.18 mm/h) in the next two. In conservative technology (no-till) it is very high, with values of 50.43, 52.88, and 57.76 mm/h at the 25-30 and 45-50 cm depths.

It can be said that water infiltration rate is very high in both soil works systems so there is no risk of water stagnation, the more so as the soil has a low clay content.

In the classical system the soil has an optimal aeration, with total porosity values between 50.8 and 53.6% v/v and in no-till the total porosity is very high, the soil is strong to moderately loose (moderate aeration), with total porosity values of 54.7-52.1% v/v in the first two sampling layers, while in the third one the soil is moderately settled (moderately deficient aeration), with a 46% v/v value.

The soil reaction (pH) is weakly alkaline in classical technology, with values in the range of 7.98-8.24. In no-till the soil reaction is weakly acidic in the first two sampling layers, with 6.58-6.41 values, while in the third one (45-50 cm) it is neutral (7.00).

One can say that the no-till technology no longer mobilized calcium carbonate ($CaCO_3$) from the soil profile depth as compared to the classical technology that mobilizes calcium carbonate through the deep soil works.

The soil is moderately supplied with humus (%) in the no-till system on the whole soil sampling depths, with values between 2.32 and 2.92%. In conventional system the soil is moderately supplied only in the first two layers (2.32-2.92%) and has a small content in the third (45-50 cm; 1.67%).

The total nitrogen content (Nt%) is medium (0.154%) at the 5-10 cm depth and small (0.116-0.118%) in the following ones in the classical system. In the experimental field where no-till technology was applied, the total nitrogen content is small (0.131-0.117%) at the 5-10 and 45-50 cm depths, while at 25-30 cm is medium, with a 0.141% value.

The mobile phosphorus content (P_{AL}, mg/kg) is medium (27 mg/kg) in the first layer, small (10 mg/kg) at 25-30 cm, and very small (4.6 mg/kg) at 45-50 cm in the classical system. In no-till technology the mobile phosphorus content at the 5-10 cm depth has a value of 29 mg/kg, which means a medium soil supply, it reflects a large supply (40 mg/kg) at 25-30 cm and is small (9.4 mg/kg) at 45-50 cm.

The mobile potassium content (K_{AL}, mg/kg) is medium (143 mg/kg) at 5-10 cm; small and very small (66-50 mg/kg) on the last two depths in the classic system. In no-till the mobile potassium content is small, with values between 74 and 119 mg/kg at all three soil sampling depths.

One can say that the two technologies of soil works do not influence the content of phosphorus and potassium.

The degree of base saturation (V %) in Haplic Chernozem falls within the eubasic range (soil saturated in bases), with a value of more than 97%; this is due to the calcium carbonate ($CaCO_3$) content.

CONCLUSIONS

The first year of experimentation with the no-till technology brought about a slight improvement of soil physical characteristics.

Ihe infiltration water permeability in both soil works systems is very high so there is no risk of water stagnation, which is also due to the low clay content.

No-till technology no longer mobilized calcium carbonate ($CaCO_3$) from the soil profile depth as compared to the classical technology that mobilizes calcium carbonate through deep soil works.

No-till technology is ideal for the Afumați, Dolj County, Haplic Chernozem in the conditions of the 2023-2024 agricultural year.

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