Available online at www.soilscience.ro

Soil Forming Factors and Processes from the Temperate Zone 13 (2014) 11-14

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PHYSICAL PROPERTIES OF TYPICAL CHERNOZEM WITH MODERATE HUMUS CONTENT USED UNDER ORCHARDS AND FIELD CROPS AFTER DEEP TILLAGE IN THE CENTRAL PART OF MOLDOVA

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Abstract

One of the directions of contemporary pedology is the research of processes occurring in soil. The importance of this problem is to know the methods of directing the processes in the soil, to create optimal conditions for plant growth and development, preservation and increase soil fertility and protection from negative technological processes (compaction, structure degradation etc.). A strategic direction for the development of horticulture consists in the efficient operation of plantations with unspent potential and successive replacement with advanced technologies that bring early bearing, high productivity of competitive organic fruit demanded on domestic and foreign markets. Anthropogenic factors leading to degradation of the soil cover is maximum involvement of land in traditional agriculture (especially fruit growing) leading to humus loss, structure degradation, compaction and erosion.

Keywords: soil, profile, deep tillage, texture, bulk density, porosity, structure, structural aggregates, water stable aggregates, structure coefficient

1. INTRODUCTION

At the establishment of orchards a special preparation of the soil is made in order to create favorable conditions for the development of seedlings. Once the trees were planted in holes with different sizes, but later occurred the possibility of transforming the soil on the entire area by deep tillage. This need occurred mainly in regions with predominance of less deep, skeletal soils. Over time, this technology has been widespread also in regions with black soils with deep soil profile. Deep tillage presents a radical transformation of the vertical profile of the soil. At deep tillage the genetic horizons are interblended, on the surface is moved B horizon (in the case of deep soils), a part of the surface horizon is buried at a depth of 50-60 cm. Transformation of soil by deep tillage is more unsatisfactory as the thickness profile is lower. A clear and convincing indicator of this is the vertical profile of humus after deep tillage. In soils with thick humus profile its content become almost the same in all humus layer, the underlying horizon remaining unchanged. Deep tillage of eroded soils leads to changes in its vertical profile, which depends on the degree of erosion. Because of deep tillage, orchards soils, having an advantage at the beginning of vegetation of seedlings, later

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Received: 10 jun 2014
Accepted: 18 nov 2014

become less permeable, more easily subject to erosion and degradation (Ursu, 1998). Currently, in some cases, deep tillage is carried out at replacement of former orchards with new plantations. This "overlapping" of deep tillage presents a destruction of soils on slopes. Because the land use in orchards caused different degradation processes in deep tilled soils, repeated deep tillage will conduct to deepening of tilled layer at the expense of lower soil horizon or upper layer of mother rock. This will condition worsening of soil properties and aggravation of degradation processes (Ursu, 2000).

Currently, Moldova has 106,000 ha of orchards, of which 80% of the area is occupied by apple trees. The orchards are planted on soils previously deep tilled that present a special type of anthropogenic soils that require a special processing. A strategic direction of sustainable development of horticulture is to gradually replace depleted orchards with orchards of new type potentially productive and fruit quality of 1.3 to 1.5 times higher than those applied previously. The establishment of these plantations is performed exploiting the full potential of each sector, ecological, biological, technological, economic characteristic of agricultural land, taking into account the climatic, physical and geographical factors etc.

2. MATERIALS AND METHODS

The aim of the research was the evaluation of physical properties of a deep tilled typical silty chernozem with moderate humus content, located on a slope of 4 degrees (profile 1 - slightly eroded located at the top of the slope and profile 3 at the bottom of the slope, used for four years in orchard, respectively profile 2 and 4 previously used in vines and recently deep tilled) and the identification of changes in the quality state of chernozem after second deep tillage used in field crops (corn the first year, wheat next year, crop residues shredded and placed under furrow) during preparation for planting the orchard. We monitored during two years the physical properties of soil and soil processes that directly and indirectly affect plant life, forming a functional assembly unit called soil organic complex: the assessment of the quality of soil and their importance to the agroecosystems, emphasizing changes in soil physical quality and factors influencing these changes. For comparison we evaluated parallel soil in the neighboring orchard. We have studied a number of physical properties that have importance for the development of fruit trees: structure, density, porosity.

3. RESULTS AND DISCUSSION

Research conducted on typical silty chernozem with moderate humus content demonstrates that during its use under field crops soil physical properties improve, bulk density decreases with 0.02-0.08 g/cm3 in the 0-30 cm layer, and with 0.01-0.02 g/cm3 in the underlying horizons, which leads to corresponding increase of both total and aeration porosity in 0-30 cm layer and at depth (Tab. 1). If the 0-10 cm layer is characterized as very loose, the 10-50 cm layer as loose, when used in orchard deep tilled soil is characterized as moderately loose and compacted (Canarache, 1990).

Soil structure has a special significance for pedogenetic processes and its fertility. Soil structure is an inherent characteristic of the soil, of great importance for physical processes in part and for the chemical and biological processes that occur in soil and the system soil - plant - atmosphere (Jigău, 2009). In the case of deep tilled soils, when after plowing the underlying layer with a low content of humus and poorly structured is brought on surface, soil structure changes considerably. In the case of deep tilled soils used in field crops soil structure improves, it can be noticed a decrease of structural aggregates >10 mm by 2% for the profile 2 and by 5-10% in the case of the profile 4 in the 0-30 cm layer (table 2). The increase of medium size aggregates content

demonstrates clearly that improving of the structure takes place due to decrease of content of blocky aggregates and increase of valuable aggregates, which demonstrates and structure coefficient (Ks). The increased content of 10-0.25 mm aggregates in the case of deep tilled soil under field crops with crop residues introduced in the furrow implies that application of organic waste reduces mechanical effects of the structure in anthropogenic pedogenesis. Another development is going in deep tilled soils used in orchards where there is a tendency for structure destruction and compaction with increasing of blocky aggregates in 0-30 cm layer.

Table 1. Values of bulk density and total porosity for the studied profiles

Depth, cm	ρ_b g/cm^3	P_{tot} %	ρ_b g/cm^3	P_{tot} %	ρ_b g/cm^3	P_{tot} %	ρ_b g/cm^3	P_{tot} %	ρ_b g/cm^3	P_{tot} %	ρ_b g/cm^3	P_{tot} %
	orchard		corn		wheat		orchard		corn		wheat	
	Profile 1.		Profile 2				Profile 3		Profile 4			
0-10	1.18	55	1.14	57	1.13	57	1.19	55	1.11	58	1.09	58
10-20	1.46	45	1.35	48	1.33	50	1.40	48	1.36	49	1.33	50
20-30	1.49	44	1.35	48	1.34	49	1.39	48	1.37	48	1.35	49
30-40	1.47	45	1.37	48	1.36	49	1.39	48	1.37	48	1.35	49
40-50	1.47	45	1.37	48	1.37	48	1.39	48	1.37	48	1.36	49

One of the most important criteria for the agronomic assessment of structure is water stability of the aggregates. It is known that the arable layer of chernozems have a stable settlement if they contain more than 40-45% of water stable aggregates with diameter >0.25 mm, otherwise the soil is subject to compaction and deterioration of physical properties, especially water and air permeability (Kuznetsova, 1979). This can serve as a basis for argumentation and theoretical foundation of different tillage methods which in practice will ensure the preservation of water stability of aggregates >0.25 mm at a level of 40-45%. Deep tilled soils used in field crops are characterized by the content of water stable aggregates >25 mm (51 -59%) with good water stability, while soils used in the orchards with a content of water stable aggregates >25 mm (39-44%) with low water stability.

4. CONCLUSIONS

From the conducted research on deep tilled typical chernozem with moderate humus content used in field crops (corn the first year, the next year wheat, crop residues shredded and placed under furrow) in comparison with those used in orchards we can say that the deep tilled soil used in field crops is restoring its physical parameters.

1. The bulk density of 0-30 cm layer is reduced by 0.02 to 0.08 g/cm3, and the underlying horizons by 0.01-0.02 g/cm3.

2. Total porosity increased by 1-2%, which leads to increase of aeration porosity correspondingly.

3. There is an improvement of the structure by lowering of blocky aggregates content and raising mezzo aggregates content.

4. Provides maintenance of good water stability of aggregates >0.25 mm at a level greater than 45%.

Table 2. Values of aggregate diameters

Depth, cm	Aggregate diameter, mm; numerator - the result of dry sieving; denominator - the result of wet sieving											
	Profile 1. Orchard				Profile. 2							
					Corn				Wheat			
	>10	7 - 0,25	>25	K_s	>10	7 - 0,25	>25	K_s	>10	7 - 0,25	>25	K_s
0-10	44.00	53.30	97.30 40.25	1.14	41.10	55.30	96.4053.60	1.24	38.40	57.90	96.3055.94	1.38
10-20	44.40	53.10	97.50 39.07	1.13	41.00	55.70	96.7053.80	1.25	38.60	59.60	98.2056.48	1.47
20-30	38.30	56.90	95.20 44.28	1.37	40.10	57.30	97.4054.62	1.34	38.70	59.80	98.5058.38	1.49
30-40	38.90	57.80	96.70 43.45	1.37	35.40	62.50	97.9057.10	1.67	30.00	67.20	97.2058.84	2.05
40-50	30.40	65.20	95.20 44.60	1.85	32.50	64.20	96.7058.12	1.79	29.80	66.80	96.6058.82	2.01
	Profile. 3 Orchard				Profile. 4							
					Corn				Wheat			
0-10	43.50	54.80	98.30 42.90	1.21	33.00	58.80	91.8051.93	1.43	23.70	71.50	95.2055.87	2.51
10-20	42.00	54.30	96.30 41.60	1.18	35.40	61.10	96.5055.59	1.51	30.70	67.30	98.0056.78	2.06
20-30	38.60	59.70	98.30 44.40	1.48	35.20	62.40	97.6055.58	1.66	30.10	67.50	97.6058.87	2.08
30-40	35.00	64.60	99.60 44.80	1.82	32.90	63.80	96.7049.53	1.76	29.50	67.80	97.3058.33	2.11
40-50	32.80	64.70	97.50 44.70	1.83	31.10	65.80	96.9058.61	1.92	29.90	67.50	97.4059.98	2.08

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