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TILLAGE SYSTEM INFLUENCE UPON SOIL QUALITY FACTORS

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ABSTRACT

Soil tillage works by their direct actions and indirect ones influenced the layer of tiled soil and its sub-tilled layer (Gus et al., 2004).

The quality of the soil tillage and seed bed is directly related with different factors, the leading one consisting as the soil type. The soil type influences through texture, structure, humus content and total Na capacity exchange.

Research results underline the relationship between the soil tillage quality and the amount of clay regarded as the capacity of soil fragmentation after a tillage system, the optimum moment for soil tillage, soil humidity in the arable layer. The type of predecessor plant and soil humidity also influenced the quality of soil tillage.

INTRODUCTION

The agronomic value of soil structure is given in particular by its influence exerted on soil settlement status and thus on the water, air, nutritional, thermal and biological regime.

A soil with good structure is slightly permeable, retains water within capillary pores and between aggregates there is air. As a result, on the surface of soil aggregates there take place anaerobic processes leading to mobilization of nutrients; meanwhile, within the aggregates develop processes leading to the accumulation and retention of humus. In this way, a balance between humification and mineralization is being created. Along with the degradation of soil aggregates, the capillary pore volume is reduced and water retention capacity decreases, evaporation being more intense, as well as erosion.

Growing plants in general and soil tillage system used especially involves the soil structure in two opposing processes: the destruction and the recovery one. The system capacity to favor one or the other of these processes result in deterioration or improvement of soil structure.

Human interventions on soils to the establishment and maintenance of crops, bring important changes in energy relations of pedogenesis and induce phenomena of ‘disruption’ of the natural evolution of the soil. Following such changes, particularly in the arable layer, it creates an artificial environment, where the changes of soil characteristics are variable depending on the type and intensity of tillage system. Tillage causes in the first place changes of physical characteristics and in particular of soil structure, which further influences soil chemical and biological characteristics.

MATERIAL AND METHODS

The present results where obtained in the experimental plots of the Agricultural Faculty of Cluj-Napoca, Soil Science Department, on a Faeoziom soil, with a humus content of 4.72%, a pH of 6.8, sandy-loam texture (43-45% loam in the Ap horizon) (V-74%), medium content of nitrate (0.204%), good content of potassium (149 ppm) and good content of phosphorus (18 ppm).

From the climatic point of view the experimental plot area is characterized by multi annual precipitation with values between 550-650 mm. The thermal regime has values between 8.0-8.2ºC.

The experiment was conceived as a monofactorial one:

1 – worked with reversible plough
2 – worked with chisel
3 – worked with paraplow
4 – worked with rotary harrow

RESULTS AND DISCUSSION

The system of soil tillage with plough, chisel, paraplow and rotary harrow influenced the quality of soil structure by modifying the weight of macroaggregate fractions and the microaggregates percent in the 0-10 cm depth (Table 1).

Compared to the control, where the soil was worked with plough, in the variants worked with conservative unconventional systems chisel and paraplow, the stable aggregates percent is maintained or increases. The increase is identified in the chisel work variant, with a value of 3.2%.

Compared to the ploughed classic system, where the percent of hydrostable macroaggregates is 95.4%, in the conservative systems with chisel and paraplow, the quality of structure is maintained and improved, the stable macroaggregates percent being 95.05% for paraplow work, and 98.6% for chisel work.

The mechanic effects of rotary harrow in 0-10 cm depth lead to a decrease or degradation of soil structure quality, the percent of hydrostable aggregates being 85.85%, approximately 10% smaller than in classic variant, with plough.

Table 1

Influence of soil tillage system on the quality of soil structure

No. of fractions	Size of aggregates (mm)	Tillage system			
		Plough (%)	Chisel (%)	Paraplow (%)	Rotary harrow (%)
I	> 5	10.20	17.70	17.20	11.55
II	5 - 3	15.65	13.65	11.40	9.40
III	3 - 2	13.95	10.80	13.20	7.60
IV	2 - 1	39.50	37.30	25.25	25.10
V	1 – 0.5	10.45	10.60	15.15	20.50
VI	0.5 – 0.25	5.65	8.50	12.85	11.70
Total content of macro aggregates		95.40	98.55	95.05	85.85
VII	Total content of micro-aggregates	4.60	1.45	4.95	14.15

The looseness degree of soil, determined at the end of production cycle, confirms the differences related to the soil work and the depth of collecting the soil samples (Table 2).

Table 2

Bulk density values (g/cm^3) varying with de soil tillage system

Specification	Depth (cm)	Soil tillage system			
		Plough	Chisel	Paraplow	Rotary harrow
Bulk density, g/cm^3	0-10	1.22	1.28	1.28	1.10
	10-20	1.26	1.36	1.33	1.35
	20-30	1.28	1.39	1.39	1.40
	30-40	1.35	1.42	1.39	1.40
	40-50	1.43	1.44	1.43	1.44

The differences in looseness are observed between the soil working ways only in the first 30 cm, no change being observed beyond this depth. In the first 30 cm, the best looseness degree was registered on the plot worked with plough, where the bulk density was lower than 1.28 g/cm^3, and the lowest looseness was registered on the plot worked with rotary harrow, where the bulk density is 1.40 g/cm^3. In what concern the looseness degree at the beginning of the production cycle, obvious differences are recorded in the first 10 cm depth, where rotary harrow gave bulk density values of 1.10 g/cm^3 and the plough 1.22 g/cm^3. For the variants worked with chisel and paraplow, the apparent density values are virtually equal, 1.28 g/cm^3. Differences can also be observed in the 10-20 cm depth, with the mention that the best looseness is registered in the plough variant, followed by the paraplow, rotary harrow and chisel variants.

The quality of germination bed, especially number of clods, their size and the amount of vegetal remains, is different, varying with the tillage system used as basic work of soil (Table 3).

For the ploughed variant, the degree of clods grinding is 78.65%, the clods having an average size of 57 mm and an apparent density of 1.20 g/cm^3, and the optimal depth for sowing is ensured.

As for the uniformity of the germination bed, on argic phaeozem, the rotary harrow variant gave the lowest rippling coefficient, 1.11 at soil surface and 1.18 at the base of germination bed. The degree of clods grinding was the best, 81.7% compared to all other variants used.

Table 3

Characterization of germination bed based on soil working variant

Feature	**Plough**	**Chisel**	**Paraplow**	**Rotary harrow**
Clods (% g/g) VM with $\Phi > 5$ mm IV	21.35 11.9-30.8	21.2 12.2-30.2	21.1 15.0-27.2	18.3 10.4-26.2
Degree of grinding (% g/g)	78.65	68.8	68.9	81.7
Balanced average VM diameter (mm) VI	3.85 3.5-4.2	4.6 2.7-6.5	4.65 2.4-6.9	3.2 2.3-4.1
Average VM size (mm) VI	57 51-63	56 49-62	56 48-63	53 45-61
Uniformity of germination bed surface – rippling coefficient	1.21	1.12	1.09	1.11
Uniformity of the germination bed base - rippling coefficient	1.19	1.21	1.25	1.18
Apparent VM density (g/cm^3) VI	1.20 1.0-1.40	1.28 1.01-1.35	1.26 1.01-1.32	1.1 0.9-1.30
Vegetal residues at the surface	few	many	many	many

VM-average value, VI-interval of variation

In the unconventional systems, worked with chisel or paraplow, the quality of germination bed secure the introduction of seeds in soil, with the mention that the grinding degree is under 68.9% (for plough variant GM=78.65%, for rotary harrow variant GM=81.70%), the average diameter of clods is 4.60 mm, the apparent density is 1.26-1.28g/cm^3, and many vegetal residues are at soil surface.

At the unconventional systems, the depth for preparation of germination bed is smaller, which creates vulnerability when water lacks for seed germination, leading to risks on soils with clayey and clayey-sandy texture in droughty years. The more vegetal remains are in the germination bed worked with unconventional systems, the greater is the benefit for water accumulation, microorganisms' activity, erosion prevention but lower for seeding.

CONCLUSIONS

1. The plough tillage system, chisel, paraplow and rotary harrow influenced the soil structure quality by percent modification of the soil fragmentation (macroagregates and microagregates) distinct values on the soil depth between 0 and 10 cm. Compared with the control, the experimental variants where the soil was tilled using unconventional methods like chisel and paraplow the percent of stabile aggregates is maintained or increased. These values are more obvious for the chisel soil tillage system with an increase of 3.2%. Compared with the plough tillage system where the macroagregates percent is 95.4 % the conservative systems like chisel and paraplow maintain or improve the soil structure quality, the macroagregates percent recording values of 95.05% for the paraplow tillage system and 98.6% for the chisel tillage system. The mechanical effects of the rotary harrow on the depth of 0-10 cm lead to a degradation of soil structure quality, the percent of hidrostabile aggregates reaching values of 85.85% with 10% smaller than the control.
2. The loose capacity differences are recorded between different tillage systems only in the firs 30 cm soil depth. After this depth, any differences were not observed. For the first 30 cm soil depth the highest loose soil capacity was recorded for the plough tillage system where the apparent density hasn't overcome the value of 1.28 g/cm^3, on the other hand the lowest loose soil capacity was recorded for the rotary harrow tillage system with a value of bulk density situated at 1.40 g/cm^3.
3. The quality of the seed bed, especially the number of lumps, their size and the quantity of vegetal residues is different with the adopted tillage system. For the experimental variant tilled with the plough the fragmentation number of the lumps 78.65%, with an average size of 57 mm and a bulk density of 1.20 g/cm^3, assuring an optimum depth for seed emergence. Regarding the uniformity of the seed bed on the argic phaeozem soil, for the rotary harrow

tillage systems where observed the lowest percent of uniformity of 1.11 on soil; surface and 1.18 at the seed bed base. The fragmentation degree of lumps recorded the highest values 81.7%, compared with all the tillage systems studied. The unconventional tillage systems, chisel soil tillage or paraplow soil tillage the quality of the seed bed offers seed emergence capacity with the prediction that the lumps fragmentation degree did not exceed the limit of 68.9% (for the plough tillage variant GM=78.65%, rotary harrow tillage system, GM=81.70%), the medium diameter of lumps is 4.60 mm, bulk density 1.26-1.28 g/cm^3 and many vegetal residues at the soil surface.

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