RESEARCHES REGARDING THE AGGRESIVENESS OF THE ACTIVE PARTS OVER THE SOIL

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Abstract

Researches aiming to establish the effect of the active parts of the agricultural units over the soil's physical degradation were developed; several variants regarding the machinery used for soil tillage, for maize growth, were taken into account (including hoeing). For each variant the bulk density and soil penetration resistance were measured, as well as the average weighted diameter and the water stability of the soil elements. Based on the experimental results the best variant was established, considering soil compaction and structure.

Key words: soil compaction, structure deterioration

Physical degradation of soil due to the effect of the active parts of the agricultural tillage machine includes structure damage, but also a certain soil compaction.

Mechanical destruction of the soil's structural elements is a consequence of the friction between soil and the active parts of the agricultural tools, of the repeated displacement over the field of the mechanical means, of the soil levigation caused by the active parts (through cutting and knocking).

Soil tillage, performed when soil humidity is not appropriate, also contributes to the destruction of soil structure. When plowing is performed at a low humidity, large clods are produced, imposing an increased number of passes of the tillage equipment. When humidity is too high, „straps" are built up, which, after drying, also imposing an increased number of passes of the tillage equipment.

MATERIAL AND METHOD

Researches were performed in order to evaluate the soil's physical degradation due to the action of the active parts of different agricultural machinery, used for maize tillage and seeding (including hoeing). For each tested variant the soil's bulk density, penetration resistance, weighted mean diameter of the structural elements and their stability were evaluated. Table 1 presents a summary of the tested variants.

Table 1

Experimental variants for maize tillage and seeding

Agricultural machinery for maize tillage and seeding	Experimental variants
OPAL 140 plow; GD-3,2 disc harrow; SPC-8 seeding machine; CPU-8 tiller (2 hoeings)	V_1 (witness)
OPAL 140 plow; BS 400 A wing-tined cultivator; SPC-8 seeding machine; CPU-8 tiller (2 hoeings)	V_2
OPAL 140 plow; FRB-3 rotary harrow; SPC-8 seeding machine; CPU-8 tiller (2 hoeings)	V_3

The reversible OPAL 140 plow, with 4+1 plow bodies was mounted on the Valtra T-190 tractor. The same tractor was used together with the BS 400A compactor and the Breviglieri FRB-3 rotary harrow. The U-650 tractor was used for the rest of the tested machinery (the GD-3,2 disk harrow, the SPC-seeding machine and the CPU-8 tiller).

The tests were performed in 2009-2010, on a cambic chernozem type of soil, with a clay loam texture and average values of the apparent density and humidity. The field slope was 1.5 – 2 degrees, and sunflower was the precursory crop.

The four indices referring to soil compaction and structure were evaluated ten days after the maize was seeded.

RESULTS AND DISCUSSIONS

The researches were performed in a monofactorial experiment, aiming to evaluate the effect of the different tillage and seeding

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machinery over the indices referring to soil compaction (bulk density and penetration resistance) and structure (weighted mean diameter of the structural elements and water stability of aggregates).

Soil bulk density is one of the indices used in order to evaluate soil compaction. *Table 2* summarizes the results concerning the bulk density, after maize seeding. The bulk density is presented for different depths (0-10 cm, 10-20 cm, 20-30 cm, 30-40 cm); the average bulk density, for the depth of 0-40 cm, is also shown.

An analysis of the results presented in *table 2* leads to the conclusion that a wide range of variation was recorded for the bulk density (between 1.09 g/cm^3 to 1.613 g/cm^3), while a narrower range of variation was reported for the average value of bulk density (between 1.308 g/cm^3 la 1.388 g/cm^3).

Table 2

Bulk density after maize seeding

Experimental variants	Depth (cm)				
	0 - 10	10 - 20	20 - 30	30 - 40	Media (0 – 40)
	Soil bulk density (g/cm^3)				
V_1 - witness	1,206	1,246	1,486	1,613	1,388
V_2	1,195	1,296	1,443	1,579	1,378
V_3	1,109	1,234	1,414	1,476	1,308

It is obvious that the lower values of bulk density were recorded for variant V_3 (when the FRB-3 rorary harrow was used), while the highest values were achieved when the GD-3.2 disk harrow was used for tillage.

In the meantime it is clear that, for all the tested variants, the soil's bulk density increases when depth increases. The lowest value if bulk density was recorded into the 0-10 cm soil layer, because soiul loosening is performed by both the plow and the other tillage machinery. A slightly higher bulk density was recorded into the 10-20 cm soil layer, because, at this depth, the soil loosening effect is produced only by the plow. A higher bulk density was recorded for the 20 – 30 cm soil layer, compared with the 10 – 20 cm layer, because this depth was not reached by the active parts of any of the tested equipments.

According to the agrotechnical requirements the bulk density for a soil with a clay loam texture should be comprised between 1.05 g/cm^3 and 1.58 g/cm^3. The results presented in Table 2 show that the required bulk density was achieved for all the variants, the 30-40 cm depth of the witness variant being the only exception.

Taking into account the average values of the bulk density registered for the four working depths and the agrotechnical requirements, the following results were obtained:

- variant V_3 – low bulk density (between 1.19 and 1.31 g/cm^3) and slightly loosened soil;
- variants V_2 and V_1 - average bulk density (between 1.32 and 1.45 g/cm^3) and slightly compacted soil;
- none of the tested variants recorded high bulk densities (between 1.46 g/cm^3 and 1.58 g/cm^3) or moderately compacted soil.

Variant V_3 was ranked first, with the lowest value of the bulk density.

Soil penetration resistance. The results regarding this index are presented in Table 3. The penetration resistance was evaluated at eight different depths; the average value, for the 0-40 cm depth, is also shown.

A significant variation of the penetration resistance was noticed (between 0.105 MPa and 0,469 MPa), while the average values were comprised between 0.256 and 0.335 MPa.

The best results in terms of penetration resistance were registered by variant V_3 (when the FRB-3 rotary harrow was used for soil tillage), while the worst results (higher values of the penetration resistance) were attained by variant V_1, when the GD- 3.2 disk harrow was used.

In all the tested variants, soil penetration increased with depth.

When considering the penetration resistance, several ranges of values are established according to the agrotechnical requirements: very low (under 1.1 MPa), low (1.1-2.5 MPa), medium (2.5-5.0 MPa), high (5.1-10.0 MPa), very high (10.1-15.0 MPa) and extremely high (over 15 MPa). From this point of view, for all the tested variants the penetration resistance was very good (very low).

Table 3

Soil penetration resistance after maize seeding

Experimental variants	Depth (cm)								
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	Media (0 – 40)
	Soil penetration resistance (MPa)								
V_1 - witness	0,135	0,206	0,297	0,323	0,409	0,419	0,429	0,469	0,335
V_2	0,108	0,177	0,276	0,322	0,357	0,376	0,388	0,413	0,302
V_3	0,105	0,158	0,231	0,239	0,322	0,326	0,329	0,339	0,256

According to the same agrotechnical specifications, the plant roots develop normaly when soil penetration resistance does not exceed 2.5 MPa. When the penetration resistance is comprised between 2.6 and 10.0 MPa, the growth of the roots is partially restricted and it is completely blocked when values over 10 MPa are recorded. Taking into account these requirements and the experimental results, it was concluded that normal growing conditions of the roots were achieved by all the tested variants.

Weighted mean diameter of the soil's structural elements. This index is referring to the degree of damage induced to the structural elements of soil. The results concerning the weighted mean diameter are presented in Table 4, for three depths (0-10 cm, 10-20 cm and 20 -30 cm) and also the average value for the depth of 0-30 cm.

Table 4

Weighted mean diameter of the soil's structural elements after maize seeding

Experimental variants	Depth (cm)			
	0 - 10	10 - 20	20 - 30	Media (0 – 30)
	Weighted mean diameter of the soil's structural elements (mm)			
V_1 - witness	3,215	3,935	4,185	3,77
V_2	3,015	3,953	4,122	3,69
V_3	2,805	3,941	4,128	3,62

The highest values for the weighted mean diameter of the soil's structural elements were recorded by variant V_1 (witness), when the GD-3.2 disk harrow was used for tillage, while the lowest values were recorded by variant V_3, when the FRB-3 rotary harrow was used.

It was also noticed that the weighted mean diameter increased with depth, due to the more significant deterioration of the soil structure towards the surface, as a result of the fragmentation caused by the active parts of the tillage machinery. The most significant difference between soil layers, in terms of weighted mean diameter of the structural elements was recorded between the 0 – 10 cm layer and the 10 – 20 cm layer; this is due to the fact the 0 – 10 cm soil layer is processed by the active parts of all the tested equipments, while the second soil layer (10 – 20 cm) was processed only by the plow. None of the tillage equipments processed the 20-30 cm soil layer.

When considering the weighted mean diameter of the soil's structural elements, several ranges of values are established according to the agrotechnical requirements: very good weighted mean diameter (2-5 mm), good (1-2 and 5-7 mm) etc. Taking into account these specifications, it was concluded that the weighted mean diameter is very good for all the tested variants.

When considerring the average values of the weighted mean diameter, for the depth of 0-30 cm, the variant V_3 was ranked the first, because the value of 3.62 mm is the closest to the value of 3.5 mm (the middle value of the 2...5 mm interval), while the witness variants was ranked the third.

Water stability of the soils's structural elements – index I_1. This is the second index used to evaluate the degradation of the soil's structural elements. The results concerning this criterion are presented in Table 5; three depth layers were considered (0-10 cm, 10-20 cm and 20-30 cm), but the average values, for the 0 – 30 cm depth, are also shown.

Based on the recorded results and taking into account the average values for the 0-30 cm, it was established that the highest value of the I_1 index was recorded by variant V_3, when the FRB-3 rotary harrow was used, while the loweste value was achieved by the witness variant, that used the GD-3.2 disk harrow for soil tillage.

Table 5

Water stability of the soil's structural elements (index I_1) after maize seeding

Experimental variants	Depth (cm)			
	0 - 10	10 - 20	20 - 30	Media (0 – 30)
	Water stability of the soil's structural elements (index I_1)			
V_1 - witness	1,804	4,327	4,578	3,56
V_2	2,050	4,016	4,778	3,61
V_3	2,366	4,150	4,581	3,70

It was also noticed that water stability increases with depth, the explanation being the same presented when the weighted mean diameter was discussed. The increase of the value of the I_1 index was more significant when passing from the 0-10 cm soil layer to the 10-20 cm soil layer, due to the same facts as the one presented earlier.

When considering the water stability of the soil's structural elements, several ranges of values are established according to the agrotechnical requirements: very good structure, when I_1 = 3-5, good structure, when I_1 = 0.61-3 etc. From this point of view, the soil structure was very good for all the three variants taken into account.

Variant V_3 was ranked the first, with a value of the I_1 index very close to 4 (the middle value of the 3...5 interval), while the variant V_1 was ranked the third.

CONCLUSIONS

For all of the variants and working depths, soil bulk density was appropriate, the lowest value being achieved by the variant V_3 and the highest one by variant V_1.

The soil penetration resistance is very low (very good) for all of the variants and working depths; the lowest values were recorded for variant V_3 and the highes values for the witness variant.

The weighted mean diameter of the soil's structural elements is good for all the variants and working depths; variant V_3 was ranked the first, variant V_1 being ranked the last.

The water stability of the soil's structural elements (index I_1) is very good for the variants. Variant V_3 was ranked the first and variant V_1 was ranked the last.

Taking into account all the indices, it was concluded that variant V_3 was ranked the first.

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