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NEGATIVE EFFECTS FROM PACKING HAPLIC KASTANOZEM SOIL AND METHODS OF DIMINISHING THEM

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ABSTRACT:
Soil packing results from the impact of mechanical and natural factors but it can also occur as an effect from mechanical destruction of the aggregates when the soil is tilled in the condition of inappropriate moisture content.
The present work points out particular values for the main soil indices characterizing soil packing and some of the negative effects resulting from growing corn in the conditions of Haplic Kastanozem after applying different types of tillage. At the same time there are specific suggestions concerning soil conservation technique for the solution of this significant agricultural problem.

KEY WORDS:
soil compaction, soil packing, negative effects

1. INTRODUCTION

According to Cherepanov G.G. and M.Chudinovskih (1987) soil packing represents a process of closer (denser) location of the structural aggregates resulting from the impact of mechanical and natural factors. The specific pressure of tractors, agricultural machinery and transport equipment present the mechanical factor while the gravity force and rainfalls, especially with dry and bare soils, relate to the natural ones. Besides, some authors believe that soil packing can result from mechanical destruction of the aggregates when the soil is tilled in the condition of inappropriate moisture content [1; 4].

Packing degree is determined through some indices to which Puponin A. (1984) and Vitlox O. (1984) relate bulk density, overall porosity and soil hardness. They are inter-related and have great significance on the growth and development of the agricultural crops.

The research work of Todorov F. et al (1982), Stoynev K (1985), Cherepanov G.G. and V.M. Chudinovskih (1987) and other authors show that the negative effects resulting from the soil packing are various and include: deterioration of the soil water-and-air and thermal conditions as well as the plants' nutritional conditions, retardation in the development of the root system and yield decrease, increase in soil erosion, overgrowing in weeds and infestation, decrease in fertilizer efficiency, increase in tillage cost, etc.

According to Stoynev K. (1985) this problem and its negative effects are hard to resolve due to the many-sided interaction of the agricultural equipment, the soil features, the crops which are grown, the climatic conditions, etc. The same author believes that quality tillage, carried out with proper agricultural machinery and in due time within the field management terms, is one of the most significant means for decreasing the negative effect of soil packing.

Based on that we carried out research work for determining the effect of different types of tillage on soil packing itself as well as on some of its negative effects.

The goal of this work is to point out particular values for the main soil indices characterizing the soil packing and some of the negative effects resulting from growing corn in the conditions of Haplic Kastanozem as well as selecting the most expedient tillage technique for the problem solution on the basis of the above research.

2. EXPOSITION

The research was carried out within the period of 2005-2006 in the experimental field of the Experimental Station on Erosion Control –Ruse in the area of the village of Trastenik, the district of Rousse, in Haptic Kastanozem soil of medium erosion and average slope gradient of 5°.

The following versions of one-factor field tests, carried out in the block method, in four versions, with four repetitions were set and completed for the purpose of this research:

- a_1 – corn, which is grown with minimum tillage;
- a_2 – corn, which is grown with zero-tillage;
- a_3 – corn, which is grown with soil conservation tillage;
- a_4 – corn, which is grown with conventional tillage – check-test.

Table 1 presents the different types of tillage carried out with the separate test versions during the research period.

Table 1. Types of tillage with the separate versions at the test on corn – 2006

Type of tillage	Versions			
	a_1	a_2	a_3	a_4
Primary tillage	- Without DAP*; - Soil-breaking with dead-furrowing at a depth of 40 cm	Without DAP*	- DAP* at 28 – 30 cm - Soil-breaking with dead-furrowing at a depth of 40 cm at intervals of 9 m at DAP*	DAP* at 28 – 30 cm
Pre-sowing tillage	- Chisel tillage at 12 - 15 cm - twofold cultivation at a depth of 10cm	Without pre-sowing tillage	Twofold open- field cultivation at a depth of 10 cm	Twofold open-field cultivation at a depth of 10 cm
Sowing	Ordinary	Direct	Ordinary with inter-row soil-breaking	Ordinary
Vegetation tillage	Pest control	Pest control	- I machine hoeing - II machine hoeing + soil-breaking with dead-furrowing - ridging + cutting	- I machine hoeing - II machine hoeing - III machine hoeing

Note : DAP* - deep autumn plowing

Each tillage was carried out transversely to the slope gradient. Some soil tests and biometric observations were carried out during the period.

Soil tests consisted in determining the soil indices, which characterize the packing degree - bulk density, overall porosity and soil hardness.

The results from the tests are presented in Table 2. They show that before sowing corn, at its maximum growth and after harvest the values of the bulk density and hardness are the lowest while the overall porosity value is the highest at utilizing soil conservation tillage. The highest bulk density and hardness and the lowest porosity are obtained at zero-tillage and the results, which come close on them, are the values of these indices at minimum tillage. This proves that the two types of tillage cause high degree of Haptic Kastanozem soil packing especially during long summer droughts as it happened in the summer of 2006. The higher degree of packing has negative effect on the corn growth and development, which is best, proved by the root system size and weight, shown in Table 3, by the overgrowing in weeds, shown in Table 4 and the yield, shown in Table 5.

Table 2. Bulk density (g/cm^3), overall porosity (%) and soil hardness kg/cm^2) in the 0 – 40 cm layer at the test on corn – 2006

Version	Before sowing			At maximum growth			After harvest		
	Bulk density	Overall porosity	Hardness	Bulk density	Overall porosity	Hardness	Bulk density	Overall porosity	Hardness
a_1	1,33	50,9	9,72	1,34	50,6	13,15	1,46	46,1	27,07
a_2	1,36	49,8	13,66	1,43	47,2	17,17	1,49	45,0	29,85
a_3	1,23	54,6	7,17	1,28	52,8	9,96	1,24	54,2	18,82
a_4	1,24	54,2	8,64	1,32	51,2	11,99	1,36	49,8	23,95

Table 3. Weight (g) and size (cm^3) of root system on soil monolith (144 x 70 x 50 cm) in phases at corn tests – 2006

Developmental phase	Version							
	a_1		a_2		a_3		a_4	
	weight	size	weight	size	weight	size	weight	size
Phase of 5 leaves	6,0	5,1	3,9	3,7	13,8	15,6	7,3	6,7
Phase of 9 leaves	23,4	19,1	12,6	15,5	61,9	60,3	41,4	38,3
Growing tassels	202,3	192,2	185,5	168,3	292,6	255,5	241,2	228,4

Table 4. Number of weeds per m^2 at corn tests – 2006 г.

Period of reporting	Version			
	a_1	a_2	a_3	a_4
Before sowing	22	87	-	-
Before hoeing	123	184	59	81
Before harvest	251	323	131	188

Table 5. Average corn yield at 14% moisture content – 2006 г.

Version	Yield		Differences proof
	kg/da	Specific yield, %	
a_1	348,5	90,1	o o o
a_2	296,2	76,6	o o o
a_3	465,1	120,2	+ + +
a_4	386,9	100	

GD 5 %	7,07	1,79
GD 1 %	9,92	2,52
GD 0,1 %	15,01	3,56

At reviewing the data in the above tables it is found that at zero-tillage the size and the weight of the corn are of the lowest values, overgrowing in weeds is of the highest while the average yield is by 90.7 kg/da less than the yield from the check-test, which was conventionally tilled, and represents 76.6% of it. The results at utilizing minimum-tillage are a little better but yet inadequate. The best biometric results are obtained in version a_3, for which soil conservation tillage was carried out, and the size and weight of the corn root system are the highest, the weed overgrowing is the lowest while the average yield is by 20.2% (78.2 kg/da) higher than that of the check-test.

All above is a clear proof that some of the negative effects from the soil packing at growing corn in the conditions of Haptic Kastanozem, such as the smaller size and lower weight of the root system, the higher overgrowing in weeds and the lower average yield in this case, can diminish significantly through soil conservation tillage which consists of soil-breaking with dead-furrowing at primarily tillage and sowing, and furrowing, soil-breaking and dead-furrowing at vegetation tillage accomplished by combined agricultural machinery.

3. CONCLUSION

The tests carried out as well as the results obtained from them lead to drawing the following inferences:

1. Minimum-tillage and especially zero-tillage at growing corn on slopes in the conditions of Haptic Kastanozem cause soil packing which results in higher bulk density and hardness and lower overall porosity than the optimum values for these indices in the conditions described.
2. The negative effects from the soil packing at utilizing these methods of tillage result in less developed root system of the grown corn, higher overgrowing in weeds and significantly lower yield compared to the check-test and in this case the average corn yield at minimum-tillage decreases by 38.4 kg/da while at zero-tillage – by 90.7 kg/da respectively.
3. Decreasing the soil packing as well as diminishing significantly or eliminating completely its negative effects at growing corn on slopes in the conditions of Haptic Kastanozem can be accomplished through applying soil control tillage which consists of soil breaking with dead-furrowing at primary tillage and sowing and furrowing, soil- breaking and dead-furrowing at the vegetation tillage carried out by combined agricultural equipment.

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