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AMPLIFICATION OF SOIL COMPACTION BETWEEN RIDGES AFTER USING PLASTIC MULCH ON ENTIRE SURFACE IN PLASTIC TUNNELS FROM NORTH-EAST OF ROMANIA

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Abstract

Our studies performed on the plastic tunnels from North-East part of Romania included a field work phase (soil and biological material sampling, soil profiles description, penetration resistance determination, digital images capture), laboratory phase (chemical and physical soil analysis). Based on field and laboratory data were estimated packing density and bulk density restricting rooting. The obtained results have shown that black plastic films on the entire surface of soil favors soil compaction, in the areas located between plants rows (i), the ploughpan conducted to the waterlogging on the bottom part of ploughed layer (ii), root system poorly developed favored some physiological disorders such as Blossom end rot on tomatoes fruits (iii). Soil determination in field (penetration resistance, morphological soil indicators) and laboratory (water distribution, bulk density, size particles distribution) and quality of fruits reveled negative influence of plastic mulch. Strong soil compaction between ridges allows us to recommend avoiding plastic mulch over the entire soil surface.

Key words: *plastic mulch, ridges, penetration resistance, ploughpan.*

INTRODUCTION

In Romania, growing vegetables in plastic tunnels has greatly expanded. High plastic tunnels are simple, tall, plastic-covered structures used for early vegetables production. It is also recognized that the intensive agricultural system has a great impact on soils properties. The application of a suitable agricultural management system, according to the soil characteristics can have positive effects on the prolonging service life of the greenhouses soil.
Interest concerning to processes of physical greenhouses soil degradation developed nowadays, mainly due to increasing of technological inputs which has the effect amplification of soil degradation processes such as hardsetting, crusting, cementation, compaction etc.
Starting with 1960 plastic mulching is currently used in horticulture especially for warm-season crops such as tomatoes, cucumbers, melons, peppers, eggplants (Incalcaterra et al., 2004).
In numerous publications are mentioned some advantages of plastic mulching. The main benefits of using plastic mulch include: increasing soil temperature (i), decreasing of water loss by direct evaporation (ii), increased yield (iii), reduced nutrient leaching (iv) and improved nutrient uptake (v), getting early production (vi), ensure full control of weeds (vii), ensure maintenance of optimal water content in soils from zone with high rainfall (Streck, 1995; Henry, 2010).
Nowadays, it is using a wide range of films covering both greenhouses and soil surface as mulch. Among the main varieties of films frequently used for mulching we mention: transparent polyethylene film; black film; transparent biodegradable Mater-BiTM film; black biodegradable Mater-BiTM film, red plastic mulch, green or brown Infra-Red Transmitting (IRT) mulches, white or co-extruded white-on-black mulch, yellow and silver plastic mulch, shiny aluminum plastic mulches, blue plastic, olive plastic etc. (Incalcaterra et al., 2004; Nair et al., 2013).
Soils with clay content higher than 33% belong to the third class of capabilities for greenhouses (Florea et al., 1987) and have high susceptibility to degradation by compaction.
Frequently, greenhouses or high plastic tunnels have been set up on soils with a compact layer, such as plough pan. A plough pan layer

(pressure pan, tillage pan) is a subsurface horizon having a high bulk density and a lower total porosity than vicinity soil layers (above or below layer). The plough pan is formed as a result of pressure applied by normal tillage operations, such as plows, discs or other tillage implements.
Degradation of soil by compaction processes had evidenced in soil with coarse and medium texture, especially as cumulative effects of drip irrigation and if it was used plastic mulch (Filipov et al., 2013, 2018).
Knowing the influence using plastic mulch on entire surface between ridges is important for making decision on the sustainable exploitation of the soil resources. Some soils profiles from poly-tunnels have been studied in order to point the changes of soil properties after 5 years of vegetables grown in organic system.

MATERIALS AND METHODS

The study site was located at poly-tunnels Roznov from Moldavian Subcarpatians (Romanian: Subcarpaţii Moldovei) Cracau-Bistrita Depression-geographic area spanning in the NE of Romania, situated to the east of the Eastern Carpathian Mountains. The studied area included soils from 4 plastic tunnels.
The penetration resistance of the soils was determined using a digital penetrologger (Eijkelkamp Equipment, Model 0615-01 Eijkelkamp, Giesbeek, The Netherlands) which had a cone angle of 30° and a base area of 1 cm^2. It was carefully inserted into the soil profiles in 1 cm increments from the surface to a depth of 80 cm. Ten parallel records were made in each plot and averaged for analysis.
In order to establish the effect of black foil, used to cover the entire surface of the soil in the plastic tunnels, on the state of compactness of the soil we made 4 cross section in the middle area of the plastic tunnels.
This section comprised two ridges grown with tomato and cucumber plants and a rill between ridges. After morphological description of soil from ridges and rill, soil samples were taken from soil layers with a thickness of 10 cm to a depth interval of 0-50 cm.
The collected soil samples were analyzed in the lab, in three replicates independent each of layer. In the lab conduct size particles analyses: pH, bulk density, content of water-according to the current methodology (Dumitru et al., 2009; Lăcătușu et al., 2017). The period of study was 2017-2019.
Following the processing and analysis of the data obtained in the field and laboratory, several reclamation measures have been recommended.

RESULTS AND DISCUSSIONS

The studied soils have been diagnosed as Hipohortic Phaeozems. The clay content of these soils range from 32.4 to 38.3%.
Following studies of the soil profiles, the presence of the plough pan (Figure 1) was noticed, which we consider to be a residual effect of the agricultural technologies practiced before the establishment of the high plastic tunnels and the growing of vegetables in an ecological agricultural system. The soil is strong compacted in the plough pan layer and in the upper part of the soil (Figure 1). High compactness state of plough pan favors water stagnation, especially on the bottom part of ploughed horizon, even if it is drip irrigation practice
The strong compaction of the soil is also highlighted by the high values (3.8-5.8 MPa) of the penetration resistance recorded in the plough pan (Figure 2).
Although penetration resistance values are lower than 2.5 MPa soil is compacted, as evidenced by pedomorphological parameters in the field and by the bulk density values higher than 1.4 g/cm^3 (Figure 3).
The high values of water content in the layer 0-10 cm currently determined decreasing of penetration resistance value. Soil profile on the top of ridge with tomato plants has a smaller content of water on the depth interval 0-20 cm. We mention that the soil sampling was done after 4 weeks of the last irrigation.
The data in Figure 4 highlights the negative effect of the plastic foil on the soil by increasing the water content (resulting from the condensation of evaporated water from the irrigated soil surface) and strong compaction due to repeated movements for various works.

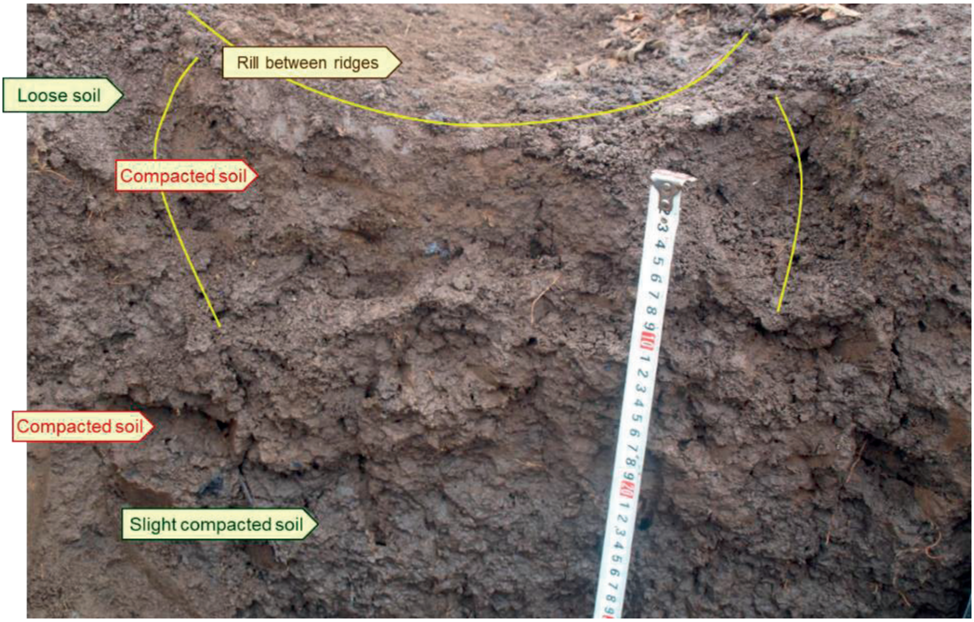

Figure 1. The state of compaction of the soil within the cross section between the two ridges

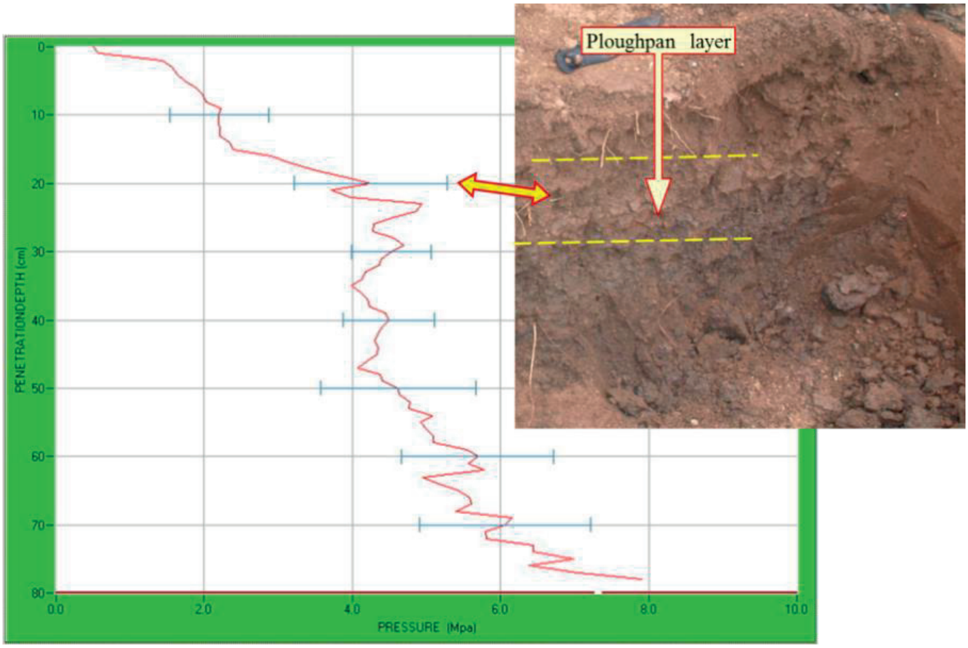

Figure 2. Strong compaction of the ploughpan layer on the rill between rows plants highlighted by high values of penetration resistance (3.8-5.8 MPa)

Depth (cm)	BD g/cm³	Average values BD (g/cm³)	Wg %	Average values Wg (%)
0-10	1,43	1,4	27.602	24.706
	1,43		22.799	
	1,34		23.717	
10-20	1,54	1,49	21.769	20.584
	1,40		19.555	
	1,52		20.430	
20-30	1,51	1,49	19.491	19.958
	1,49		20.301	
	1,48		20.082	
30-40	1.39	1,42	25.680	25.653
	1.40		25.285	
	1.43		25.994	
40-50	1.41	1,42	27.151	26.845
	1.44		26.522	
	1.42		26.861	

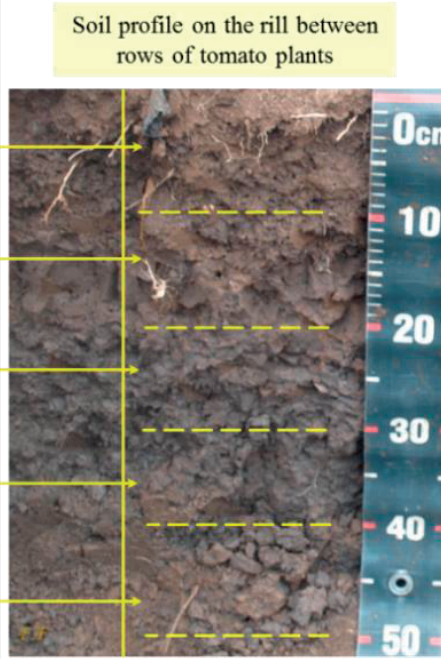

Figure 3. Soil profile on the rill between ridges with rows of tomato plants. Values of Bulk Density (BD) and gravimetric content of water (Wg) registered on the depth interval of 0-50 cm

Depth (cm)	BD g/cm³	Average values Wg (%) BD (g/cm³)	Wg %	Average values Wg (%)
0-10	1.42	1.40	15.982	16.412
	1.38		16.627	
	1.39		15.719	
10-20	1.21	1.16	18.425	16.667
	1.12		15.787	
	1.16		15.470	
20-30	1.49	1,51	19.623	19.624
	1.55		19.624	
	1.50		19.825	
30-40	1.51	1.51	21.815	23.290
	1.53		24.028	
	1.49		23.635	
40-50	1.40	1.40	23.796	23.812
	1.42		23.820	
	1.38		23.572	

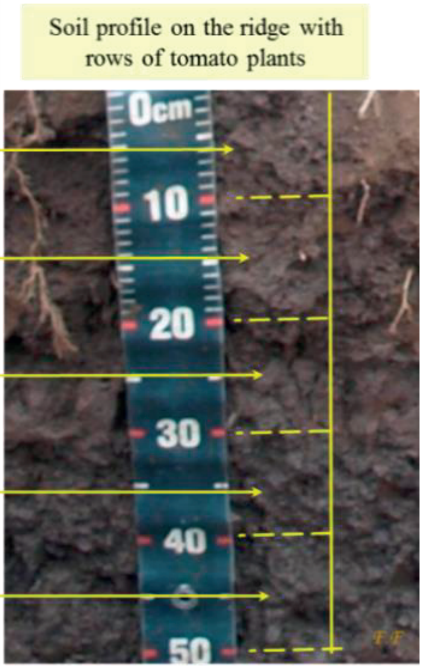

Figure 4. Soil profile on the top of ridge with tomato plants. Values of Bulk Density (BD) and gravimetric content of water (Wg) registered on the depth interval of 0-50 cm (V2)

CONCLUSIONS

The obtained results have shown that black plastic films on the entire surface of soil favours soil compaction between plants rows.

The ploughpan conducted to the waterlogging on the bottom part of ploughed layer and poorly developing of root system.

High content of water favoured some physiological disorders such as Blossom end rot on tomatoes fruits. Strong soil compaction between ridges allows us to recommend avoiding plastic mulch over the entire soil surface.

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REFERENCES

Dumitru, E. et al. (2009). *Methods of analysis used in the soil physics laboratory*. Sitech Press, Craiova.

Filipov, F., Niţă, L., Chiorescu, E. (2018) *Indicative Recognition Criteria of Degradation by Compaction and Salinization of the Greenhouses Soils with Fine Texture.* Proceedings of the international conference on life science Filodiritto Editore. 477–483.

Filipov, F., Samuil, C., Vîntu, V. (2013). Indicative Recognition Criteria of Degradation by Compaction of the Greenhouses Soils with Coarse Texture. *Proceedings of the 2nd International Conference on Agricultural Science, Biotechnology, Food and Animal Science*, WSEAS Press, Brasov-Romania, 295–299.

Florea, N., Bălăceanu, V., Răuţa, C., Canarache, A. (1987). *Interpreting soil surveys for different purposes*. Redactia de propaganda tehnica Agricola Publishing House. 166–172.

Incalcaterra, G., Sciortino, A., Vetrano, F., Iapichino, G. (2004). *Agronomic response of winter melon (Cucumis melo inodorus* Naud.*) to biodegradable and polyethylene film mulches, and to different planting densities*. In: Cantero-Martínez C. (ed.), Gabiña D. (ed.). Mediterranean rainfed agriculture: Strategies for sustainability, Zaragoza: CIHEAM, 181–184.

Henry, G. Taber and Barbara, Smith, C. (2010). *Effect of Red Plastic Mulch on Early Tomato Production*. Department of Horticulture, Ames. http://www.public.iastate.edu/~taber/Extension/Progress%20Rpt%2000/redmulch.pdf.

Lăcătușu, R. et al. (2017). *Chimia globală.* Terra Nostra Publishing House.

Nair, Ajay and Havlovic, Bernard J., (2013). Effect of Plastic Mulch Color on Tomato Production in High Tunnels. *Iowa State Research Farm Progress Reports*, 1869. http://lib.dr.iastate.edu/farms_reports/1869.

Streck, N.A., Schneider, F.M., Buriol, G.A., Heldwein, A.B. (1995). Effect of polyethylene mulches on soil temperature and tomato yield in plastic greenhouse. *Sci. Agric.*, *52*(3) (Piracicaba, raz.).