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ANTHROPOGENIC INFLUENCE ON THE PHYSICAL PROPERTIES OF SOILS IN GREENHOUSES AND SOLARIA

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Abstract

The paper addresses the influence that man has on the physical properties of the soil. Thus, a series of physical properties of soils in greenhouses and solaria are compared, namely: texture, structure, density, apparent density, total porosity, and aeration porosity following the application of organic and mineral fertilisers. The studies and research were carried out in greenhouses and solaria located in the western part of Romania (Timiș and Arad counties), in two localities, Giarmata and Secusigiu, cultivated with tomatoes (Solanum lycopersicum), peppers (Capsicum annuum) and eggplant (Solanum menongena) over a period of 9 years. The physical properties of soils were compared in 2016, 2019, and 2022, and the results showed that, in the solaria in which organic fertilisers (manure) were applied in doses of 40-60 t/ha, density values decreased from 1.12 g/m^3 to 1.08 g/m^3, apparent density from 1.65 g/m^3 to 1.54 g/m^3, while total porosity values increased from 62% to 67% and aeration porosity from 36% to 41%, thus falling within normal values of vegetable cultivation.

Key words*: anthropic influence, physical properties, protected areas.*

INTRODUCTION

Lately, man has become an active factor in soil genesis, either directly - through improvement works or plant cultivation, or indirectly - through diking, drainage, irrigation, or erosion control works (Annabi et al., 2011). Following anthropic interventions, most of the soils have evolved, in the last hundred years, under intensely modified anthropic conditions (Grosbellet et al., 2016).

Over time, the influence of man on these processes has taken various forms with different intensities, causing, in all cases, the disturbance of the natural conditions of soil genesis and, in some cases, leading to their improvement (Canarache, 1997; Mihuț et al., 2018).

The positive activity of man in the evolution of soil and its fertility is also materialized through amendments and fertilizers (Okros A., 2015)

By correctly applying the fertilizers, not only the crops, but also the suitable properties of the soils increase, for example, tri-calcic phosphates enrich the cationic component of the colloidal complex, and organic fertilizers increase the microbiological activity, as well as its porosity. However, irrationally applied organic fertilizers can create pollution situations in the soil and even imbalances in plants (Goian & Ianoş, 1993).

Agricultural wastes can be used as a source of organic matter and nutrients for soils and influence the physical properties of soils. They can also be easily applied as mulching, providing numerous advantages (Rico et al., 2016). So, this chapter gives an overview of the positive effects of recycling vegetable wastes and soil physical properties (Diacono et al., 2010).

Soil structure is one of the most important soil's physical factors controlling or modulating the flow and retention of water, solutes, gases, and biota in agricultural and natural ecosystems (Lal et al., 1991; Young et al., 1998). Soil structure is very important in soil productivity and is a limiting factor of crop yield (Cotching, 2018).

The physical properties of soils condition their quality and, in particular, the porosity which affects different processes related to the transformations of organic matter, gas exchange, the growth of plant roots, and movement of water in the soil, as before it was indicated (Archer et al., 2006).

Soil porosity is the property that, due to the effect of compaction, is being altered largely in the European Union (and developing countries), together with the loss of organic matter from soils, and, for this reason, our management of the soils should allow maintaining this property at adequate levels (European Commission, 2015).

Bulk density is an important indicator of soil quality, productivity, compaction, and porosity. BD is mainly considered to be useful to estimate soil compaction. Root length density, root diameter, and root mass were observed to decrease after an increase in BD (Dal Ferro, 2014). However, the interpretation of BD with respect to soil functions depends on soil type, especially soil texture and soil organic matter (SOM) content (Six, 1998).

The two locations in which the research was carried out are in the western part of Romania, in Giarmata: it is in the central-northern part of Timiş County, 11 km from Timişoara, 1.3 km from Timişoara International Airport; Secusigiu is in Arad County and is located south of the Mureș river, on CR Arad-Sânnicolau Mare (Țărău et al., 2007; Mircov et al., 2021).

MATERIALS AND METHODS

The research was carried out in 8 protected areas, 4 on each location in Timiș and Arad counties, in two locations, Giarmata and Secusigiu, cultivated with tomatoes (*Solanum lycopersicum*), bell peppers (*Capsicum annuum*) and eggplant (*Solanum menongena*) for a period of 9 years. The soil is of the anthropic chernozem type following fertilization in Secusigiu, and of the vertic preluvosol in Giarmata, to which river sand was added in 2014, when the 4 solaria were built.

Considering that, in these protected areas, a series of vegetables are cultivated (3 crops/year), it is necessary to apply higher amounts of fertilizers. Fertilizers (organic and mineral) were applied, namely, manure in doses of 20, 40, and 60 t/ha, every 3 years; as mineral fertilizers, by irrigation, Solfert was used, in a doses of 10 kg/ha.

The first phase of the study was based on the method of observation and description. Such activities were carried out in the two locations with surprisingly different aspects of the soils. Soil samples were collected in the spring, before the basic crop.

During the 9 research years, a series of soil samples were collected from the 0-20 cm profile both in natural and disturbed settings and laboratory analyses of the following physical features of the soil were performed:

- Soil texture (%) was determined with the Cernikova method;
- Soil density (SD-g/cm^3) was determined with the picnometer and by estimation depending on the amount of humified organic matter and on the percentage of granulometric fractions;
- Soil apparent density (AD - g/cm^3) was determined with metal cylinders with known volume in natural setting;
- Total porosity (Tp %) was determined by calculus Tp = (1 - AD/SD) x 100;
- Aeration porosity (Ap%) was determined by calculus Ap = Tp – CC x AD.

RESULTS AND DISCUSSIONS

The research was carried out in two locations (Giarmata, Timiș County, and Secusigiu, Arad County) in 8 protected areas (4 in each location), the area of a solarium being between 400 and 500 sqm. In each of the two localities, two solaria were cultivated with tomatoes (*Solanum lycopersicum*), one with bell peppers (*Capsicum annuum*) and one with eggplant (*Solanum menongena*).

In the 4 solaria in each location, the same dose of fertilisers was applied, the determination of physical features was done every 3 years, i.e., in 2016, 2019, and 2022. As it appears from the data presented in Tables 1 and 2 and Figures 1 and 2, there are no high differences between the granulometric fractions of the soil texture in the two locations.

Table 1. Influence of the anthropic factor on soil texture in Giarmata

Nr. Crt.	Particle size fraction (%)	Year 2016				Year 2019				Year 2022			
		g.g.20 th/a	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/a	Solfert 10 kg/ha
1.	Coarse sand (2.0-0.2 mm)%	15,9	15,8	15,9	15,9	16,0	16,1	16,3	16,1	15,7	16,0	16,4	15,8
2.	Fine sand (0.2-0.02 mm) %	37,7	37,8	38,0	37,7	37,8	37,4	37,5	37,6	37,6	37,6	38,0	37,7
3.	Dust (0.02-0.002 mm) %	25,3	25,4	25,5	25,3	25,4	26,2	26,9	25,3	25,5	25,5	25,6	25,4
4.	Clay (below 0.002 mm) %	21,1	21,00	20,6	21,1	20,8	20,3	20,2	21,0	21,2	20,8	20,0	21,10

Table 2. Influence of the anthropic factor on soil texture in Secusigiu

Nr. Crt.	Particle size fraction (%)	Year 2016				Year 2019				Year 2022			
		g.g.20 th/a	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/a	Solfert 10 kg/ha
1.	Coarse sand (2.0-0.2 mm)%	1,3	1,4	1,5	1,3	1,3	1,5	1,6	1,3	1,4	1,6	1,7	1,3
2.	Fine sand (0.2-0.02 mm) %	19,8	20,1	21,2	19,7	19,7	20,8	21,6	19,6	21,0	21,8	22,2	19,6
3.	Dust (0.02-0.002 mm) %	46,6	4,8	47,2	47,0	46,8	47,0	47,8	47,2	47,3	48,2	48,3	47,2
4.	Clay (below 0.002 mm) %	32,3	31,7	30,1	32,0	32,2	30,7	29,0	31,9	30,3	29,4	27,8	31,9

The application in higher amounts (40-60 t/ha) of manure has led to a slight increase in sand and dust content especially in Giarmata, where the soil was modified by adding river sand, which finally led to modifying the texture from medium clayey-loamy to clayey, thus ensuring the most suitable conditions for the growth and development of vegetables.

In Secusigiu, the texture of the soil is medium. In the variants in which higher doses of manure were applied, the fine sand values increased from 1.3 to 1.7% when 60 t/ha of manure were applied. Fine sand had values between 19.6% in 2022 (Solfert variant 10 kg/ha) and 22.2% when 60 t/ha of manure was applied (2022). Dust values varied between 46.6% and 48.3% and those of clay, between 27.8% and 32.3%.

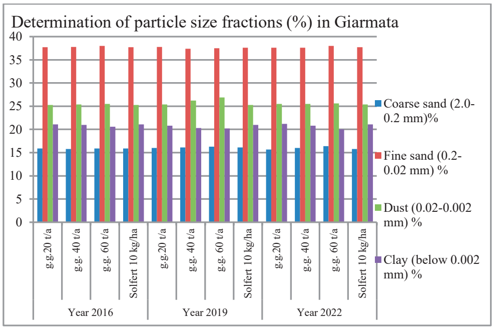

Figure 1. Influence of the anthropic factor on soil texture in Giarmata

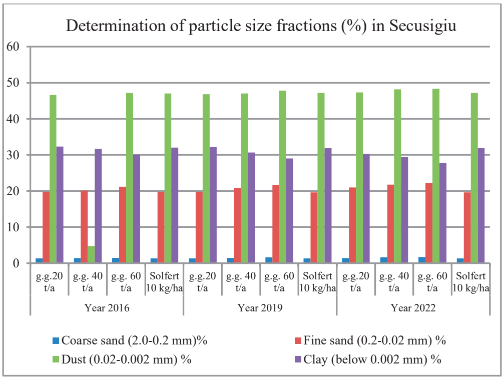

Figure 2. Influence of the anthropic factor on soil texture in Secusigiu

It can be stated that the texture of the soil did not change following the application of fertilizers since the values in the two locations were similar in all 4 solaria. There were little changes in the percentage content of the fraction of coarse sand and fine sand in the variants fertilised with higher amounts of manure, especially when applying a dose of 60 t/ha of manure.

The values of soil density and of apparent soil density in the two localities are presented in Tables 3 and 4 and in Figures 3 and 4.

Table 3. Influence of anthropic factor on soil density and apparent soil density (g/cm^3) in Giarmata

Nr. Crt.	Values obtained	Year 2016				Year 2019				Year 2022			
		g.g. 20 th/a	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g. 20 t/ha	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g. 20 t/ha	g.g. 40 t/ha	g.g. 60 t/a	Solfert 10 kg/ha
1.	Soil density (D - g/cm^3)	2.60	2.58	2.52	2.61	2.58	2.54	2.48	2.61	2.56	2.50	2.48	2.62
2.	Apparent density (DA - g/cm^3)	1.26	1.24	1.18	1.28	1.22	1.16	1.10	1.30	1.12	1.09	1.08	1.32

Table 4. Influence of anthropic factor on soil density and apparent soil density (g/cm^3) in Secusigiu

Nr. Crt.	Values obtained	Year 2016				Year 2019				Year 2022			
		g.g.20 th/a	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/ha	Solfert 10 kg/ha	g.g.20 t/ha	g.g. 40 t/ha	g.g. 60 t/a	Solfert 10 kg/ha
1.	Soil density (D – g/cm^3)	2.48	2.40	2.28	2.60	2.46	2.38	2.26	2.61	2.42	2.28	2.18	2.62
2.	Apparent density (DA – g/cm^3)	1.36	1.32	1.28	1.38	1.32	1.26	1.20	1.38	1.28	1.24	1.16	1.40

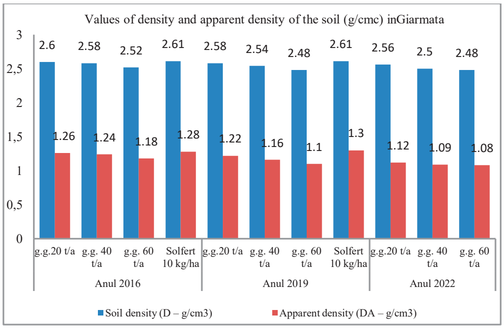

Figure 3. Influence of anthropic factor on soil density and apparent soil density (g/cm^3) in Giarmata

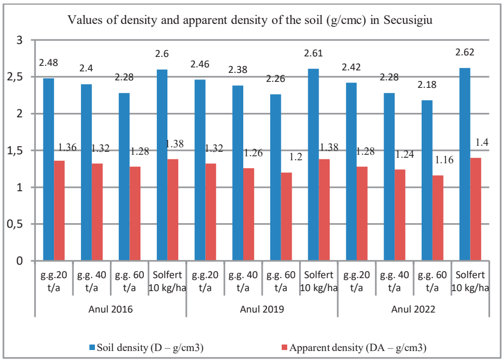

Figure 4. Influence of anthropic factor on soil density and apparent soil density (g/cm^3) in Secusigiu

The density of the soil in Giarmata had values between 2.62 g/cm^3 in the case of Solfert application in 2022, and 2.48 g/cm^3 in case of application of organic fertilization (manure 60 t/ha).

Soil apparent density had values of 1.09 g/cm^3 in the g.g. 60 t/ha and 1.32 g/cm^3 in the variant in which Solfert was applied in doses of 10 kg/ha.

In Secusigiu, the values of soil density and of soil apparent density were lower: 2.62 g/cm^3 in the mineral fertilized variant in 2022, and 2.18 g/cm^3 in the variant fertilized with 60 t/ha of manure also in 2022, when soil apparent density values were between 1.16 g/cm^3 and 1.40 g/cm^3. Higher values were found in the variants where Solfert was used in the organically fertilized variants. The higher the amount of manure, the lower the soil density and soil apparent density values.

Lower values were recorded in organically fertilized variants, and higher values in variants where mineral fertilizers were applied through fert-irrigation.

Tables 5 and 6 and Figures 5 and 6 present the values of total porosity and of aeration porosity in the two locations.

In Giarmata, total soil porosity had low values of 44-45% in the variants fertilised with Solfert by fert-irrigation and high values of 58% for the variant fertilised with 60 t/ha of manure (2022). Aeration porosity had values between 12-16% in the variants in which manure was applied in doses of 60 t/ha and between 9.20-9.40% in the variants in which Solfert was applied.

In Secusigiu, total porosity had values between 40-42% in the variants fertilise with Solfert, and 46-55% in the organically fertilized variants. Aeration porosity had values between 9.2-12.10% in the variants in which organic fertilizers were applied and between 8.7-8.90% in the variants in which mineral fertilizers (Solfert) were applied.

Table 5. Influence of anthropic factor on total porosity and total aeration porosity (%) in Giarmata

Nr. Crt.	Values obtained	Year 2016				Year 2019				Year 2022			
		g.g.20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha	g.g.20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha	g.g.20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha
1.	Total porosity (PT %)	47	48	50	46	49	52	54	45	50	54	58	44
2.	Aeration Porosity (PA%)	9.80	10	12	9.60	10.2	14	15	9.40	14	15	16	9.20

Table 6. Influence of anthropic factor on total porosity and total aeration porosity (%) in Secusigiu

Nr. Crt.	Values obtained	Year 2016				Year 2019				Year 2022			
		g.g. 20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha	g.g. 20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha	g.g. 20 t/a	g.g. 40 t/a	g.g. 60 t/a	Solfert 10 kg/ha
1.	Total porosity (PT %)	46	48	50	42	47	49	52	40	48	51	55	40
2.	Aeration Porosity (PA%)	9.20	9.72	10.40	8.90	9.80	10.80	11.50	8.80	10.30	11.90	12.10	8.70

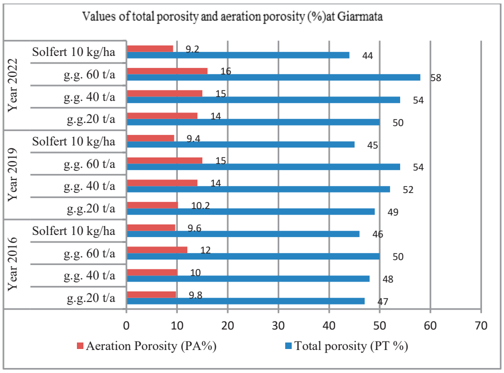

Figure 5. Influence of anthropic factor on total porosity and total aeration porosity (%) in Giarmata

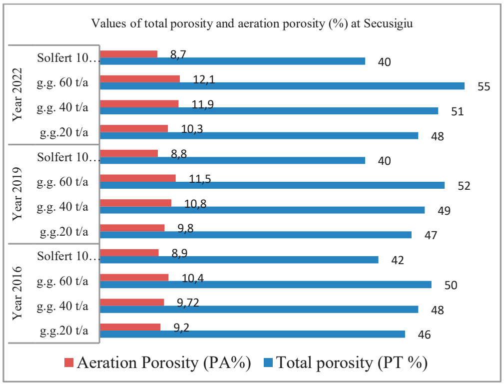

Figure 6. Influence of anthropic factor on total porosity and total aeration porosity (%) in Secusigiu

CONCLUSIONS

Following the research conducted in Giarmata and Secusigiu, the following conclusions can be drawn:

- Following the anthropic intervention on the vertic preluvosol in Giarmata, its initial features were significantly modified, especially on the surface, in the processed horizon (0-20 cm), in the sense that the content in fine and coarse sand increased and clay content decreased, because of both the application of manure in high doses (40-60 t/ha) and the administration of river sand in the amount of 10 t/ha;
- In Secusigiu, the chernozem has a medium clay texture, the variants fertilised with manure had a content in fine sand between 1.3% and 1.7% in the variant in which 60 t/ha of manure was applied, fine sand had values between 19.6% and 22.2%, dust had values between 46.6% and 48.3%, and clay had values between 27.8% and 32.3%;
- Soil density in Giarmata had values between 2.62 g/cm^3 and 2.48 g/cm^3 and soil apparent density had values between 1.09 g/cm^3 and 1.32 g/cm^3;
- In Secusigiu, the values of soil density were between 2.62 g/cm^3 and 2.18 g/cm^3 and those of apparent density, between 1.16 g/cm^3 and 1.40 g/cm^3;
- The highest values were recorded in the variants where Solfert was used and the lowest values were recorded in the organically fertilized variants.
- Total sol porosity in Giarmata had values between 44-58% and aeration porosity had values between 9.20-16%;
- In Secusigiu, total porosity had values between 40-55% and aeration porosity values were between 8.7 and 12.10%.

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