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Original Article

Use of Soil Conditioners in Greenhouses Soils

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Abstract

The paper had as main objective the orientation to unconventional resources and protecting ecosystems, with significant participation in flow optimization of substances and nutrients, in limiting the use of resources and potentially harmful inputs. Greenhouse soils are subject to intensive technologies that determine deep changes of the upper layers of soil, especially the aggregation capacity, so require solutions to improve the structural condition, with implications for quality indicators that define the productive capacity of soils. Use of soil structure conditioners proved an effective measure, especially for heavy degradation of the soil structure, as evidenced in the current research of using soil conditioner under the culture of vegetables where there was a clear increase of stability of soil aggregates (from 49.1% to 68.4%) and consequently an improvement in physical and chemical properties of the soil. Research has highlighted also a distinction of structural composition of stable aggregates categories and that applying soil conditioner in double dose (4 L/ha) results no major differences, not being economic nor sustainable.

Keywords: soil structure, soil conditioners, soil quality indices, hydro-physical indices.

1. Introduction

Soil conditioning gives soils the needed physical properties to allow plant growth, fight erosion, or save water [6].

As soil conditioners various materials have been used, from organically derived materials too synthetic materials as copolymers of hydrolyzed polyacrylonitile (HPAN), vinylacetatemaleic acid (VAMA), polyvinyl alcohol (PVA), polyacrylamide (PAM). Their uses have been primarily for soil structure stabilization but the interest in stabilizers has advanced and receded several times in the last years as new classes of stabilizers or new uses for them have been identified [21].

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Soil structure has a major influence on soil behaviour. A ”well structured” soil has a good porosity, permeability, friability and trafficability. The arrangement, quantity and distribution of pores and fissures within a matrix of solid materials determines water holding capacity, infiltration, permeability, root penetration, and, respiration. Not only the soil structure but also the stability of the structure is of major importance. Structural stability determines the ability of a soil to withstand imposed stresses without changes in its geometric structure and functions [19].

The physical disintegration of the soil structure may be produced by the impact energy of the raindrops or as consequence of the rapid wetting of the soil [1, 13, 15].

Because using large quantities of water the structure in greenhouses is quite unstable. In this conditions some physical properties of the soil, such as aggregate stability, hydraulic conductivity, and infiltration rate are affected. Under water-drop impact a structural seal at the soil surface is formed [15], characterized by greater density, higher strength, finer pores, and lower saturated hydraulic conductivity than the underlying soil [3].

Aggregates stability (AS) refers to the ability of an aggregate to withstand the distractive applied forces, as water drops (sprinklers irrigation). Intensive tillage and irrigation causes the breakdown of stable aggregates and loss of organic matter [5].

Soil structure is a quality index of soil, understanding soil structure presents some benefits concerning soil tillage, water circuit (retention and movement), trafficability, irrigation management, water run-off, organic matter cycling, air permeability.

Therefore, it is very important to maintain the stability of the soil structure during its wetting. Becoming increasingly used, one way of increasing the stability of greenhouses' soil structure is soil conditioners, which are substances that improve the physical and chemical properties of soils [2, 7, 8, 12, 14, 16, 19, 22, 24].

Polymers in average have diameters of 0.5 - 1.0 μm [20], and chains are flexible, with multiple segments, and poly-functional. The polymers are mainly characterized by their molecular weight, molecular conformation (coiled or stretched), type of electric charge, and charge density.

These traits determine their adheration to the soil particles, of clay fraction, mainly. PAM treatments were found to be very effective on reducing soil erosion by connecting soil particules and regulating soil structure[17]. Application of N-fertilizers does not influence soil aggregates but could reduce the polymers effect on improving soil aggregate stability [23]

Polymers have water retention ability and can keep the water and some liquid fertilizers in long time and in culture soil help plant favourable growth and reduce water loss and irrigation costs [18].

The way of polymers's application influence their effect. In sprinkler application the beneficial effects in crust formation were preserved under water application without impact energy [4].

2. Material and Method

Geographically the experimental field is located in Transylvanian, Romania, at intersection between $46^0 46'$ N and $23^0 36'$ E, on the greenhouses of the University of the Agricultural Sciences and Veterinary Medicine Cluj – Napoca. A plot was established in an experimental 2500 m^2 area and it was cultivated with different tomato varieties.

The analysed material consists of the soil from the greenhouses, interpreted from the point of view of the taxonomic framing and effects after treatment with soil conditioner product (SC).

The mono-factorial experiment developed on tomato culture with 2 gradations and compared with untreated control, included: V_1 – control, V_2 – SC 2l/ha and V_3 – SC 4L/ha.

Soil conditioner product was applied in January when germinative bed was prepared. It was incorporated in soil by chopping with milling machine.

The soil samples were taken by horizons, in order to perform the pedological studies, and from the upper horizon in order to perform analyze of the effect of the product applied.

The soil samples were taken after one week of product administration in January (2010) and one year later (2011) and when the culture was stubbing, in the first half of July (12 July 2010).

Physical analyses refers to soil structure stability (wet sieving method), texture (hydrometer method), hydro-physical indices and chemical indices refers to humus content, soil reaction, carbonates content, degree of base saturation, total capacity of cations exchangeable.

The product used in experiment as soil conditioner (SC) is a uniquely formulated high grade non-ionic soil penetrant with added enzymes and a bio-stimulant.

As soil conditioner, the product helps to reducing of inlays loose clay soils, and aggregation of the sandy soils. Also allows the water and oxygen to better reach the plant roots, by reducing the superficial tension between water and soil.

The soil conditioned in this way has better water retention properties, weaker compaction, better aeration and structure.

This product also helps to improve the micro-organisms development and activity, which is necessary for a healthy environment in the soil. According to producers, the product may be mixed with majority of herbicides and pesticides as lots of fertilizers.

3. Results and Discussions

The analysed soil is formed on a levelled terrace, on clays predominant parental material and groundwater depth over 10 m.

According to Romanian Soil Taxonomy System 2012, the studied soil belongs to Antrisoils Class, Hortic Anthrosols (ATho), respectively Hortic Anthrosols (ATho) according to WRB-SR 2006 (V1 control) (Fig. 1).

The control soil is characterized by neutral reaction, degree in base saturation over 75%, high capacity of cationic exchange, high quantity of humus and middle content of carbonates (Table 1).

Table 1. The chemical properties of the Hortic Anthrosols, greenhouses USAMV (January 2010)

Variant	V_1 control
Ah	9.08
SB	35.7
T	44.78
V %	79.72
pH	7.05
H%	10.1
$CaCO_3$	2.44

The values of hydro-physical indices revealed a small value of the coefficient of hygroscopicity (3.44) and coefficient of wilting point, accordingly (5.16) (Table 2).

Table 2. The hydro physical indices and hydric stability of the peds, Hortic Anthrosols, Cluj-Napoca greenhouses (January 2010).

Variant	Water stability	CH	CO
V_1 control	49.1	3.44	5.16

Water stability of the aggregates is low, 49.1%, meaning the soil is partially structured, also demonstrated by the lack of aggregates higher than 10 mm and the very low percent of aggregates with sizes of 5 mm (2.85%).

A higher percent was recorded to micro-aggregates with sizes smaller than 1 mm, of 12.45% for these of 0.5 mm and 15.4% for these of 0.25 mm, respectively (Table 3).

Table 3. The percent of aggregates established function of the sizes of the structural aggregates – untreated control (V_1)

Sieve	g	%
I (5 mm)	0.57	2.85
II (3 mm)	1.00	5
III (2 mm)	0.56	2.8
IV (1 mm)	2.12	10.6
V (0.5 mm)	2.49	12.45
VI (0.25 mm)	3.08	15.4

The analyses of soil in variants with SC revealed an improvement of the soil properties, especially regarding the water stability of the soil aggregates and hydro-physical indices, improvements that have been preserved until culture stubbing on July (Table 4). The effect is immediate observed in values of water stability of the aggregates, which increases from 49.1% to 68.4% in variant where 2L/ha was administered and to 73.95% in variant where 4L/ha was administered, respectively. At the same time we observed an increase of the values of the wilting point coefficient, which when stubbing recorded much higher values, from 5.01 to 8.84 in V2 and from 5.17 to 12.54 in V3. This led us to the conclusion that soil aggregation determines in time, better water retention and circulation in soil. Comparing the results from the two variants treated with SC we can see that both increase the stability of aggregates and content of humus and hydric indicators at similar values. Therefore we recommend that efficient and economical the variant when 2 L/ha SC is applied (V_2). To see if those improvements are lasting under cultivations next year, before new tomato crop establishment we analyzed water stability of aggregates and hydric indices.

The results showed clearly that water stability has been preserved (Table 5), the values are close to those obtained in previous crop at harvesting for both variants (V_2 and V_3), which again confirms the recommendation for the application of dose of 2 L/ha SC. A good structural condition of the soil is indicated by the degree of structure but also the structural composition of the percentage of stable aggregates categories; the same degree of structure print different physical attributes. Low in small aggregates with a high percentage of large aggregates (over 5 mm) results in a compact placement inside the aggregates, influencing soil water retention and drainage [11]. The structural composition is positive modified by the product; therefore we can see an increase of percentage of the small and very small aggregates (2-0.25 mm size) from 41.25% (V1) to 55.8 and 50.76% (V2 July 2010 respectively V2 July 2011) (Fig. 2).

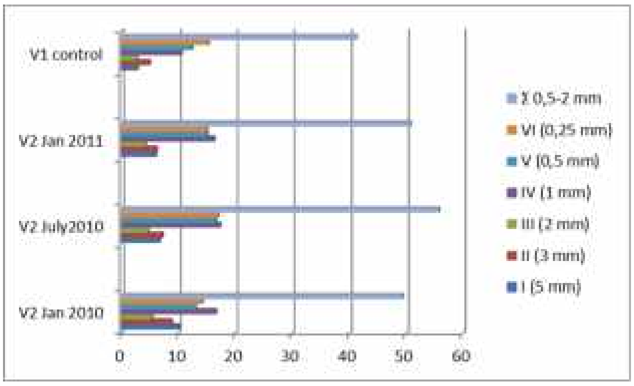

Figure 2. Structural composition on different sizes of the experimental variants and the average of small and very small aggregates (Σ 0.5-2 mm).

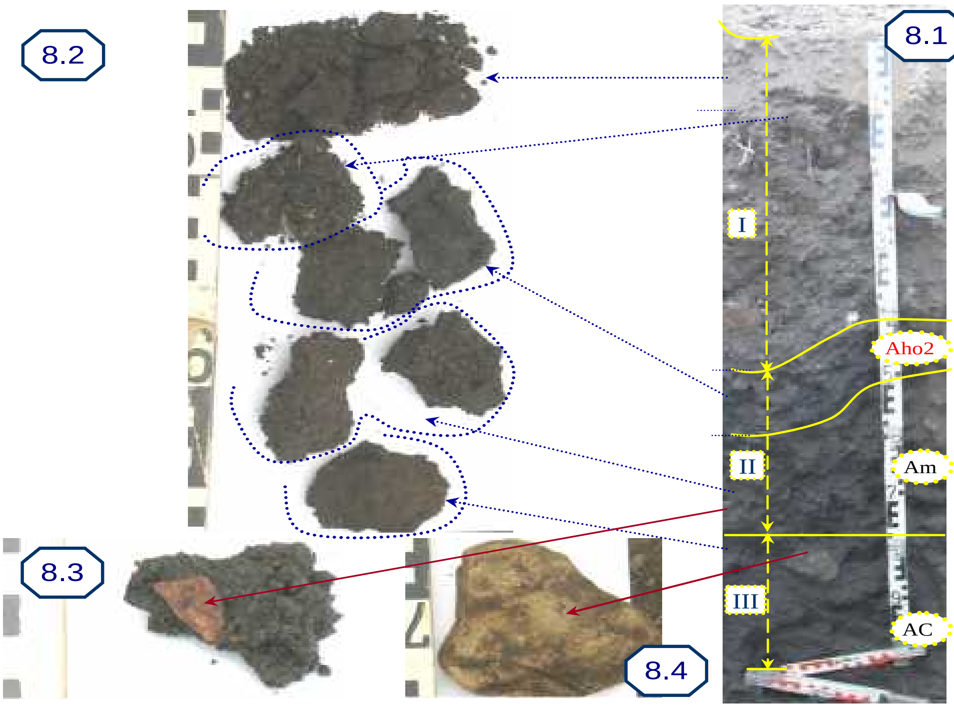

Figure 1. Hortic Anthrosols profile (8.1), soil structure (8.2), garbic materials (8.3 and 8.4).

Table 4. The physical and chemical properties of the Hortic Anthrosols in variants treated with SC (2010)

Variant	water stability (average)		CH (average)		CO (average)		Humus	
	Jan.	July	Jan.	July	Jan.	July	Jan.	July
V_2	68.4	69.8	3.34	8.84	5.01	13.26	11.42	12.45
V_3	73.95	68.0	3.45	8.36	5.17	12.54	11.2	12.14

Table 5. The physical and chemical properties of the Hortic Anthrosols in variants treated with SC (January 2011)

Variant	Water stability (average)	CH (average)	CO (average)	Humus (average)
	Jan.	Jan.	Jan.	Jan.
V_2	63.15	5.54	8.31	11.89
V_3	63.25	5.06	7.54	12.04

Table 6. The qualitative indices I_1 and I_2 (2010-2011)

I_1 Jan 2010		I_2 Jan 2010	
V_1	0.46	V_1	0.38
V_2	0.82	V_2	0.51
V_3	0.55	V_3	0.39
I_1 July 2010		I_2 July 2010	
V_2	0.55	V_2	0.51
V_3	0.42	V_3	0.39
I_1 Jan 2011		I_2 Jan 2011	
V_2	0.52	V_2	0.51
V_3	0.42	V_3	0.42

One can notice the high values obtained after treatment in both dosing, especially in variant V_2, values are maintained above control (V_1) both at the end of culture 2010 (July) and at the establishment of tomato culture next year (January).

Again we observe the efficiency of applying 2L/ha product, which becomes most sustainable (Table 6).

To qualitative estimation of the soil, Chiriţă [11] suggested the use of some qualitative indices of the structure: a) *qualitative index 1* (I_1) representing the ratio between the sum of the large aggregates category (I, II and III) and sum of the small and very small aggregates (IV and V). b) *qualitative index 2* (I_2) representing the ratio between category IV and sum of the categories V and VI.

4. Conclusions

Soil conditioner has the immediate effect of improving soil structure, both in terms of the degree of structure and water stability of structural aggregates. Increasing the degree of structure has favourable effects on hydro indices, influencing retention and water mobility into soil profile. Improving the soil structure proved to be stable throughout the growing season and next year at tomato crop, as evidenced by structural quality indices recorded at higher values compare to untreated variant. In terms of use, application of 2L/ha SC is recommended, dose at which effects on the degree of structure and the percentage of stable aggregates are sustainable.

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