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ASPECTS CONCERNING THE MANAGEMENT OF DEGRADED SOILS BY COMPACTION

BY

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Abstract. This paper intends to highlight the main causes and effects attributable to nature negative process called: compaction or settlement in some cases depending on the area in which researching takes place. In solving this unfavorable soil phenomenon, in the last half of the twentieth century the focus was on developing new techniques and technologies used in preventing and combating the stocky from natural causes or human land referred in this paper. Thus in this context was reported one of the methods to prevent and to combat this factor such as deep loosening. This process applied to improve influenced in a manner most favorable physicochemical properties and soil hydraulic.

Keywords: prevention; improvement; compacting; hydraulic conductivity.

1. Introduction

The soil compaction is one of the main causes of the phenomenon of negative character entitled degradation. From the multitude of effects due to the emergence and further development of the compaction process reduced the hydraulic conductivity and soil water but should not be neglected increasing the water retention (soil suction). In terms of hydraulic soil is a porous medium

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which is reflected in complex structure its rather complicated system of canals and trails variable called soil pores that support the movement of fluids through them. In this regard it was found that for the transport of water and chemical compounds in the soil is necessary to have two environments: solid medium (soil matrix) and a stream of water moving through the pores of the soil.

During the process pierce soil by fluid, his permeability is altered. Thus, based on dry ground, in the first instance, the permeability is high and then decreases rapidly, until the soil is saturated with water. Since then, the amount of water that enters the soil becomes constant. Water entering for unsaturated soil is made by infiltration.

We determine the rate of infiltration according to Richards's relationship developed based on Darcy's law as follows:

$$V = K \times I, \tag{1}$$

where: V is the average filtration speed, [cm/s]; K – the hydraulic conductivity or the coefficient of filtration, [cm/s]; I – the hydraulic gradient or the pressure radient (dimensionless).

Knowing that settlement may affect saturated zone, we emphasize the hydraulic characteristics by applying Darcy's law:

$$V = K_{(\theta)} \times I, \tag{2}$$

where: $K_{(\theta)}$ is the hydraulic conductivity depending on the moisture, [cm/s].

2. Soil Compaction at National and European Level

The notion of compaction or soil settlement is defined as being the physical process by which takes place the alarming increase of soil mass per unit of volume and a decrease in this porosity. At national level Research Institute for Soil Science and Agrochemistry, in collaboration with 37 offices and Agrochemical Soil Survey and other research units undertook an inventory available for 41 counties about 12 million hectares of arable land fully considered. The result of this extensive action resulted in the conclusion that about 62.5 of the total area suffer from increased compaction process, responsible for the deterioration of their quality. In early 2011 were made in situ and laboratory work in,, System monitoring of agricultural and forest soils ", performed the national network of monitoring research in the Grade 1 (16 × 16 km), thus covering , throughout the country, about 1,800 agricultural sites (Monitoringul stării de calitate a solurilor din România. ICPA, 2011).

The determinations made of Research Institute for Soil Science and Agrochemistry, within the network level 1, have enabled a dynamic monitoring

of the main parameters of soils in Romania. Field work was performed, in the most part by, Offices and Agrochemical Soil Survey and laboratory results, centralization and data processing was performed by the same institute.

If we relate this problem at European level, some estimates made points out that about 4% of Europe's soil degradation processes are affected by compaction, but the data are not precise and accurate (Eckelmann *et al*., 2006)**.** According to recent studies conducted by (Jones *et al*., 2003). More than a third of Europe's soils are susceptible to the occurrence of degradation processes by compaction in layers or horizons below the surface (Fig. 1).

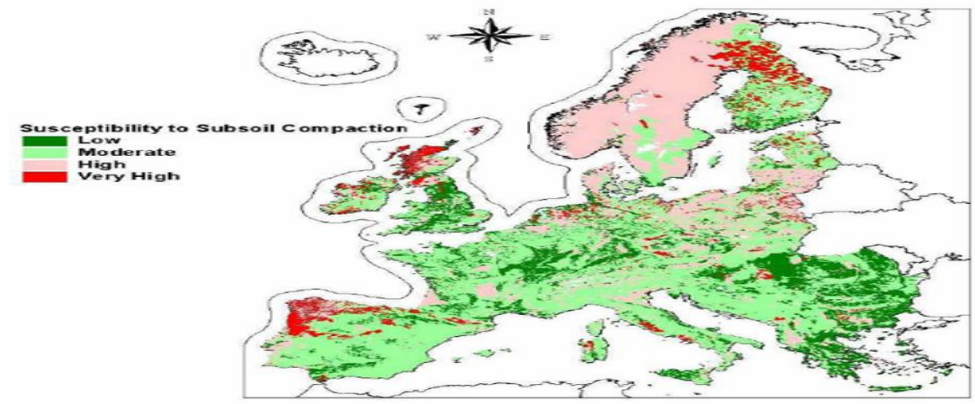

Fig. 1 – The situation at European level of soil susceptibility to the compaction process (adapted from Jones *et al*., 2001, 2003)

3. Causes and Effects of Soil Compaction

3.1 The Causes and Development of the Settlement Process

In general this phenomenon with quite serious negative consequences, is triggered and maintained by the following sources:

a) application of short rotation: rotation and monoculture wheat-corn two years;

b)absence crops ameliorative role, eg perennial legumes, perennial grasses (Lolium multiflora), etc;

c) unfavorable balance of humus and other nutrients in the soil, due to reduced fertilization, organic fertilization absence;

d) execution of works in poor of soil moisture;

e) the intensity, frequency, annual work at the same depth;

f) improper irrigation of soils with agricultural use;

g) heavy use of agricultural machines in the agricultural production.

Secondary intensity or anthropogenic subsidence intensity depends by the susceptibility or the vulnerability to compact soil, which is determined by: size and composition unbalanced, unstable structure, low humus content.

Status compactness of the soil, raising requirement as may be determined based on knowledge of the degree of compactness of the soil, which allows determining the requirement for aeration.

The degree of compactness (Stătescu & Pavel, 2011), can be calculated using the ralation:

$$GC = DA/DA_{max} \times 100, \quad (3)$$

where: GC is the degree of compactness, [%]; DA – the bulk density of the soil at a certain time, [g/cm^3]; DA_{max} – the maximum bulk density of the respectively soil, [g/cm^3].

3.2. Effects of Compaction on the Physical and Hydraulic Proprietes of Soils

The settlement or soil compaction, regardless of origin, has many negative effects, both other on the soil, environmental resources and farm productivity.

Thus, we can enumerate a range of negative effects such as:

a) reduction the soil hydraulic conductivity and increased risk of excess water;

b) increased water retention capacity;

c) worsening aerohidric regime;

d) increased resistance to penetration and inhibition of root system development;

e) increased of soil resistance to some activities for agriculture (plowing) increases;

f) degradation of soil structural aggregates: the shape, size and their stability (Fig. 2);

g) the poor quality tillage and seedbed preparation.

Fig. 2 – Effect of compaction process on structural of soil aggregates.

Fertility and production capacity of the soil, as a result of the adverse effects, considerably decreases, sometimes up to 50% compared with non-

compacted soils. Preventing anthropogenic soil compaction is achieved by adaptation of agriculture, the agro-technical and mechanical works so that minimized the negative effects and processes.

The reduction in hydraulic conductivity of soil compaction achieved by anthropogenic origin studies have showed that the values of the basic properties decrease with intensity regime that is subject to soil settlement in the location in which this happens dangerous. Thus we illustrate an experiment conducted on two clay-silty soils of the Loess Plateau, China.

Undisturbed soil samples were collected from the surface (0...5 cm) and the ground layers (10,...,15 cm) of Mizh and Heyang-. Shanxi area. The three levels of soil compaction were established by increasing soil bulk density 0% (C0), 10% (C1) and 20% (C2), compression and percussion laboratory (Shulan Zhang *et al*., 2006). After subjecting the soil samples at three levels of compaction resulted several major changes. The effect of soil compaction on hydraulic conductivity K is shown in Fig. 3. In general for Heyang soil the K values were higher in the surface layer than in layer depth (Fig. 3 left panel). C2 treatment resulted in significantly lower *K* value than the C0 and C1 treatments ($P < 0.05$), but there was no significant difference between treatments for this purpose C0 and C1.

In contrast, the values of K decreased significantly when the soil compaction increased Mizh (Fig. 3, right panel). Moreover, variations of the measurements (standard error) for each soil treatment mizh were small in comparison with the corresponding variations Heyang soil. C2 have Ki values of treatment was only 18 8% of the corresponding values for the surface and underground strata treated with the Heyang C0.

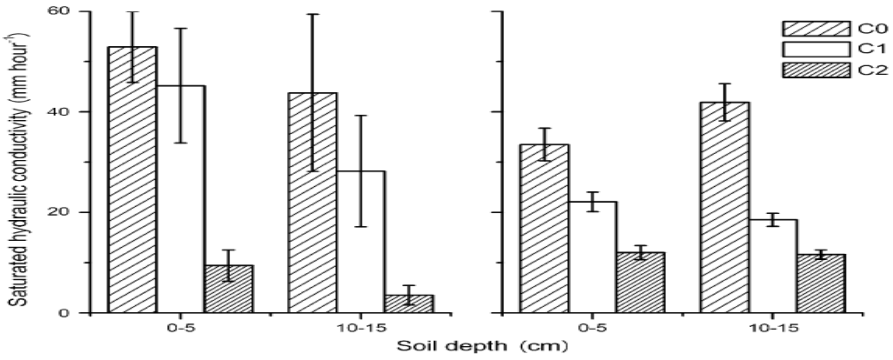

Fig. 3 – The effect of compaction on the hydraulic conductivity - at different levels of compaction of the soil (C0, 0% C1, 10% C2, 20%) of the two layers (0…5 cm and 10 cm…15 cm) of Heyang (left panel) and Mihzi (right panel). Error bars indicate standard errors (Zhang Shulan & Harald Grip, 2006).

4. Measures for Improving the Characteristics of Compacted Soils

4.1. General Issues

In the world as well as in our country has emerged as a deep loosening as important agropedoameliorative able to determine an improvement in the physical conditions of heavy soils and compacted, those affected alternative and excess moisture deficit, and other categories soils present production capacity limitations due to salinization, alkalization, pollution etc.

The notion of deep soil loosening includes all work aimed at enhancing or increasing lacunar space of arable soil horizons underlying layer works not involving mixing, inverting or reversing specific soil horizons.

4.2. Selection Criteria for Deep Loosening Soil and Conditions of Carrying Out it

Choosing soil loosening requiring work is based on a number of criteria such pedological, climatic, geomorphological and hydrogeological etc. In terms of soil - the areas occupied by fine textured soils and medium underdeveloped structure, compacted and compacted natural or artificial, including the dominant coarse textured soils, but showing the depth of 0-60 cm layers or horizons fine texture (accumulation of iron oxides) are very powerful compacts (Nițu *et al.*, 1998). Given the same criterion also includes soils that are affected by excess moisture such as rain, or have a poor overall porosity, degree of settlement of over 10% and a low permeability to water and air.

In terms of climate criteria, deep loosening is necessary and possible in all areas that meet the following conditions:

a) have normal hydroclimatic stock - excess in October-march:

$$P/\text{ETP} \times 100 \geq 110 \quad (4)$$

where: P is the precipitation; ETP – potential evapotranspiration.

b) they have an normally hydroclimatic stock - deficient in July – September:

$$P/\text{ETP} \times 100 < 90 \quad (5)$$

Geomorphology, the field must have a slope of less than 15% to allow the technical use of machinery that runs deep loosening of soil. On slopes greater fall deep loosening depending on the specific anti-erosion works. Hydrogeology, soil is considered not to be affected by groundwater influences during periods of excess moisture. Priorities for execution of the work shall be determined by the intensity of factors such fitasarea and excess aeration intensity and duration umiditate.O can not be obtained than when performed

under optimal conditions of humidity. This optimum is between 60 and 90% of active moisture range (Fig. 4). This indication is indicative because you can not give accurate figures quite humidity since they are large variations depending on the type, subtype and variety of soil. The soil should be so dry and able to withstand pressure active components that transmit force to lift the entire surface of the material.

So almost dry soil should be at least the depth at which work is carried out after a period of prolonged drought dry but not when soils can get extremely dry (moisture near the wilting coefficient).

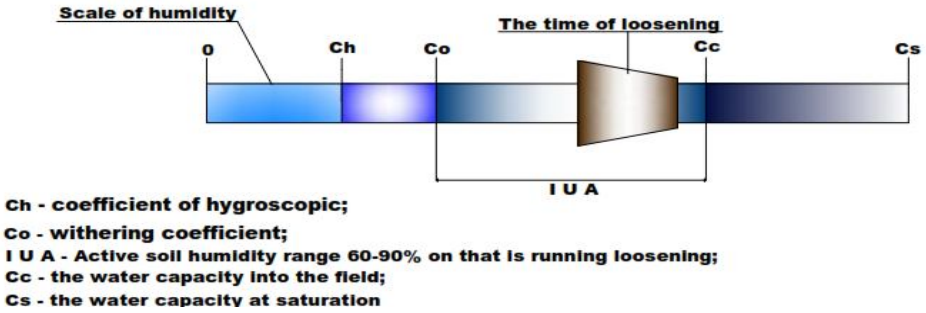

Fig. 4 – Timing of application the deep loosening in correlation with moisture scale.

4.3. Working Process and Types of Machines Used in the Process of Raising

In the process of soil loosening the soil must break fissures and cracks forming irregular structural aggregates to be displaced from each other, side and pushed to the surface so that it can no longer recover the initial confusion as would be possible if performed only a simple lift. Soil deep loosening appreciation of quality can be made after the height of the bulk material reaches the active workpiece spindle, which must be at least 15 cm from the surface of adjoining land. If the soil is too dry, breaking is the large boulders that create gaps not only large, but also difficulties in preparing land still other work surface and an excessive consumption of fuel. Sometimes not withstand the required machines and loosening no longer runs at set depths. We insist on such issues as failures are recorded in some units are most often caused by incorrect choice of the period for making deep loosening less mistakes in terms of soils that require this work (Nițu *et al.*, 1998). Loose machine (Fig. 5) is an independent ground of pregnancy loosen of soil layers located at greater depths.

The working depth is 40…90 cm, and after the configuration of the system may be rigid or vibration. If loose machines working rigid body is shaped like a sharp knife and narrow. Active bodies are arranged in a triangular

support and are numbered 2…5. Machine loose with vibration system can only work with bodies active vibration or vibration machine frame. The necessary traction force in their case is 10…25 % lower than in the case of rigid. Equipped with auxiliary devices can be used to drain, applied fertilizers, soil disinfection. Machines equipped with working loose form can be used for loosening dig at 35 cm.

Combined disc harrow can be achieved without inverting soil tillage.

Machines aerate the soil loose, prevents soil compaction, increase water permeability thereby improving water and air providing the necessary work especially important for plants with roots located at great depth (http://www.fermier-satmarean.ro/Doc/lucrarile%20solului.pdf).

a *b*

Fig. 5 – Equipment used in the method of loosening soil: *a* – MAS 7 and *b* – raising machine with various constructive organs.

4.4. Influence of the Deep Loosening on Physical, Chemical and Biological Properties of Soils

Although systematic research in climatic conditions from Romania started later compared to other countries, where deep soil loosening is widely known and applied, were obtained numerous data underlying the superiority of this work.

Thus, data obtained through experiments carried out in the country, using deep loosening lead to increased total porosity in the superior and loose depth of 2.5,...,6 %, which positively influences the water permeability of the soil.

Increasing the total porosity due to deep loosening work, destroying compact layers, as increasing water permeability have the effect of improving the storage capacity of the soil. This indicates that the water may accumulate in the soil from deep loosening quantity is 25 %,...,30 % higher than the ground unlooses.

In connection with the changes in the chemical nature of the soil caused by deep loosening, were registered on Luvisols Albic an increase of calcium 6.4 mg/100 g soil due to activating the cation. Also, the pH values increased to 0.36 units by reducing the hydrogen ion concentration and increased humus

content of 0.17% due to the acceleration of humification processes (Nițu *et al*., 1998).

We also need to improve microbiological activity in soils revealed loose change compared with aero-hydro conditions, to increase the amount of those pseudogleizate and pseudopgleic change the relation between aerobic and anaerobic microorganisms in favor of the former. As a result, increases the mineralization of organic matter, humus formation, reduction processes gley and secondary salinization under specific conditions.

The development of a vigorous root system, well branched, the maximum potential physiological conditions is a basis for obtaining high yields. Research has shown that the number of roots deep loose soils and especially their vertical distribution have changed dramatically raised the sensitivity to compaction and subsidence roots and special effects that are achieved by loosening deep (Nițu *et al*., 1998) organic matter resulting from more developed root systems. Indicated values were 2,…,3 times higher compared to soils nonloosening. Increasing air content by argillic B horizon deep loosening from specific clay-alluvial soils in class and especially.

5. Conclusions

In this chapter will be present some preventive measures proposed by the authors to avoid the negative effects of this phenomenon that unfortunately lead to soil degradation. As discussed above, this process has influenced a large extent fertilisation, soil permeability to water and air, water retention capacity etc. In this context the authors propose the implementation by farmers of the following measures to prevent soil compaction:

a) execution of works related to of optimal soil moisture status;

b) reduction and elimination of possible heavy machinery traffic attributed to inadequate moisture conditions;

c) use of agricultural machinery which would reduce the pressure on the of soil through: use of tires with low pressure of the tracks, double wheel or increase the speed of work;

d) long-term rotations that include reclamation plants;

e) techniques applied to the development of soil humus balance through proper fertilization, especially by applying organic fertilizers;

f) limitation to eliminate overgrazing.

If we refer to the state of soil compactness, it highlights two main issues:

a) on non-compacted soils necessary measures, above, precisely in order to prevent the occurrence of secondary compaction;

b) the already compacted soils, regardless of cause, for reducing excessive compaction.

Note that the physical and hydraulic properties of the soil are closely related to the degradation, characterized in that case the phenomenon of settlement, varying largely depending on the period in which the phenomenon is the deterioration of the soil.

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ASPECTE PRIVIND MANAGEMENTUL SOLURILOR DEGRADATE PRIN COMPACTARE

(Rezumat)

Se scoate în evidenţă principalele cauze şi efecte atribuite procesului de natură negativă intitulat: copactaere sau în unele cazuri tasare în funcţie de domeniu în care are loc cercetarea . În soluționarea acestui fenomen nefavorabil solului, în ultima jumătate a secolului XX s-a pus accentul pe dezvoltarea de noi tehnici şi tehnologii folosite în prevenirea şi combaterea „îndesării” terenului din cauze naturale sau antropice, menționate în această lucrare. Astfel, în acest context a fost relatată una dintre metodele de prevenire şi combatere a acestui factor cum ar fi: afânarea adâncă. Acest procedeu aplicat în scopul ameliorării a influenţat într-un mod cât mai favorabil proprietăţile fizico-chimice şi hidraulice ale solului.