ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Soil Decompaction By Frost Action.

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ABSTRACT

The article reports individual research technique and frost action of soil samples results findings that have been got to determine the effect of frost action on soil decompaction. The optimum values of the factors influencing decompaction process efficiency of compacted soil have been established. A nomogram was made up to determine the soil productive capacity after decompaction by frost action. The nomogram allows forecasting the future yield according to the guttation rate of test crops, depending on the initial soil bulk density and moisture content in autumn-winter period.
Keywords: soil, decompaction, frost action.

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INTRODUCTION

Natural decompaction and soil structure reconstitution takes place in autumn-winter period, when the soil wetted with autumn moisture starts to freeze. In the process of frost action, the soil water is crystallized and its volume increases, what leads to the breaking of soil clods into smaller aggregates and accordingly to bulk density decrease and soil structure reconstitution [1].

The efficiency of soil decompaction process by frost action largely depends on soil moisture value and rate of soil compaction. Under frost action, heaving forces arise, reconstituting soil structure to different degrees depending on soil moisture content value [2, 3, 4].

England Rotamsted Experimental Station's research results showed a high efficiency of soil decompaction by frost action in a cold winter, which made it possible to obtain soil aggregates of optimal size.

Similar data were obtained in the USA, in the western provinces of Canada, as well as in Sweden and Norway. However, in these researches it was noted that in a cold winter conditions there was a significant frost action onto plough layer and deep plough layer, but such a process had been slowly happening for several years [5].

MATERIALS AND METHODS

The aim of research tests conducted was to determine the effect of soil frost action on the process of its decompaction and to find optimum values of factors influencing the process efficiency.

The efficiency of decompaction process was evaluated by soil samples bulk density changesin the result of frost action, foolowed by thawing and finally, by soil productive capacity measurements.

Soil moisture and bulk density have been the determinative parameters of soil decompaction by frost action efficiency [4].

Decompaction degree by frost action was defined by the difference between the compacted soil samples bulk density and the soil samples bulk density after frost action in four soil moisture content variations: 25, 28, 30.5, 32.5%, and in four soil bulk density variations from 1.10 to 1.40 g / cm^3 .

The samples were prepared in laboratory facilities where soil samples were compacted by means of a hydraulic power system to the calculated volume corresponding to the required soil bulk density [6]. After that, the compacted soil samples were frozen at a temperature of -10 ... -18°C.

After compacted soil samples have been frozen, their increased volume was evaluated because of their heaving by frost. From the data obtained experimentally, dependence diagrams were generated showing the response of relative soil decompaction to the values of soil moisture and bulk density parameters.

To assess soil productivity after decompaction by frost action at different soil moisture and bulk density, an express method of soil productive capacity evaluation was used [7].

Soil productive capacity evaluation was carried out using a test-crop seeds of sprouted barley and calculation of guttate (liquid) exuded by their seedlings.

To prepare sprouted barley seeds, initially the seeds were germinated lightless for 20 hours in a TC-80M-2(Russia model) hydro thermostat at a temperature of 22 ... 23 ° C.

For testing, each selected 9 identical sprouted seeds of equal sprout size were sown in prepared soil samples. Then the samples were placed for 24 hours in a TC-80M-2 hydro thermostat with a constant temperature level of 22 ... 23˚C and a constant level of moisture saturation [8]. For this time period barley seedlings appeared and exuded guttate.

The volume of guttate exuded by gutting seedlings was estimated by the square area of the guttate spot on the filter paper impregnated with a solution of copper sulfate.

EXPERIMENTAL PART

The results of researches on determination of soil decompaction process efficiencyby frost action are shown in Figures 1 and 2.

The diagram shows that the dependence of the efficiency of soil decompaction process by frost action on soil moisture and bulk density has got a nonlinear character and a maximum point that corresponds to the optimum soil moisture value, which is in the interval 28 ... 31% for the soils with a bulk density of 1.1 and 1.4 g / cm^3.

Thus, the efficient soil decompaction by frost action had been ensured at soil moisture content not less than 28%.

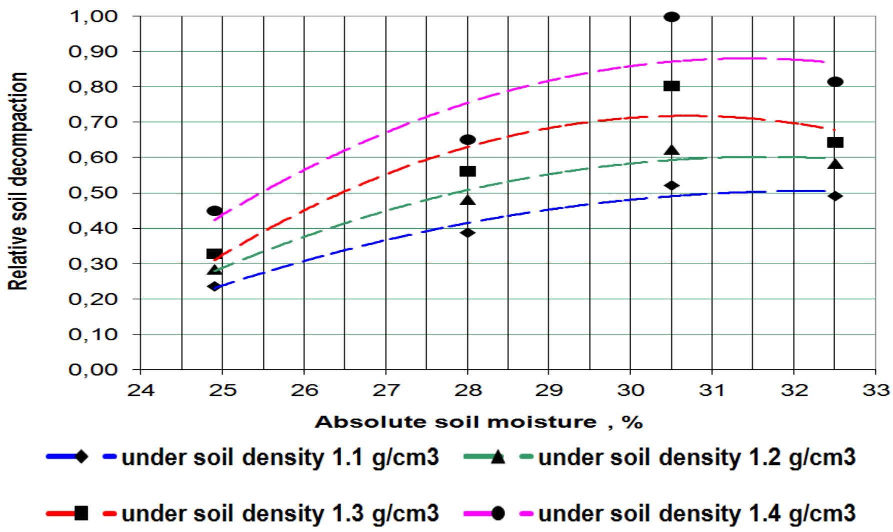

Figure 1– Relative soil decompaction by frost action

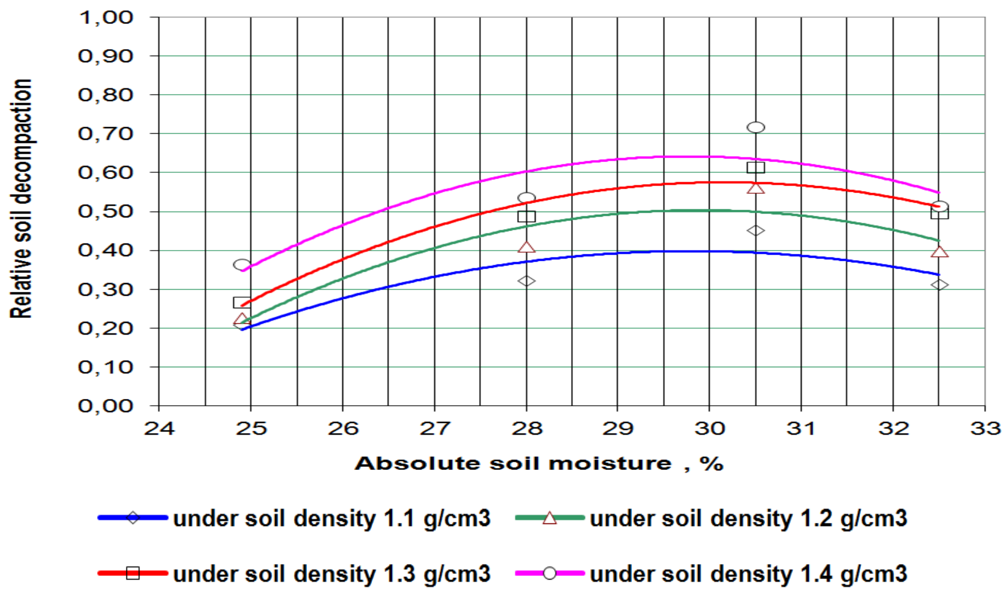

Figure 2 – Relative soil decompaction after thowing

The results of soil decompaction by frost action at soil moisture content of 28% and 30.5% were compared with data of guttation intensity. The diagram of dependence was generated (Figure 3).

The dependence has a variable character corresponding to a convex parabola with a vertex at the maximum value of the relative guttation taken as 100%. The bulk density of the soil sample decompacted by frost action, under which the test crop seedlings exude the largest amount of guttate, is the optimum level of bulk density for the considered soil moisture content level. After soil decompaction by frost action at a soil moisture of 30.5%, the optimum bulk density is 1.0 ... 1.1g/cm^3, and at a soil moisture of 28%, respectively, 0.95 ... 1.05g/cm^3.

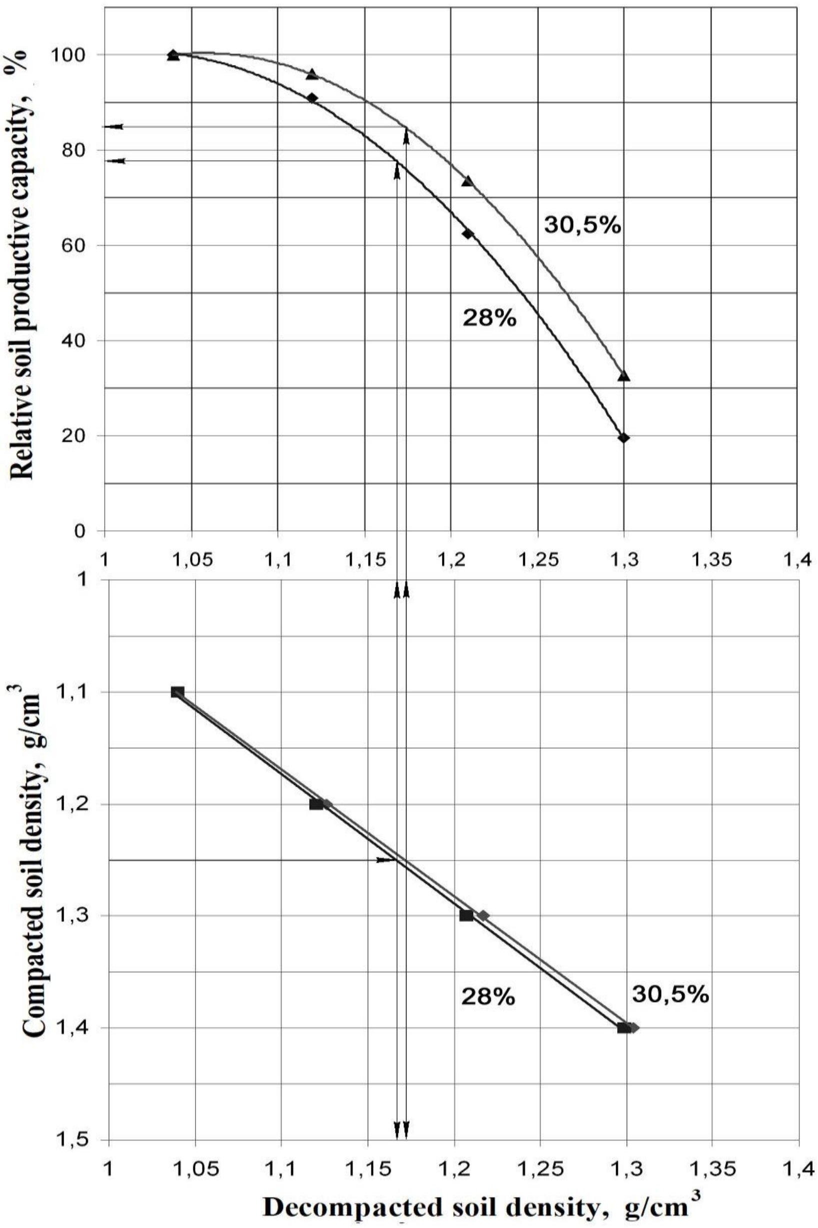

Figure 3 – Nomogram to evaluate productive capacity of soil decompacted by frost action depended on initial soil bulk density and moisture

The nomogram in Fig. 3 allows one to forecast the efficiency of soil decompaction process by frost action. For example, at the soil moisture being 28% and its bulk density being 1.25, the bulk density after frost action will be - 1.16 ... 1.17, and the relative guttation will reach 78% of the maximum possible, which will determine the level of real production yielding in relation to the maximum possible for the soil under consideration. Similarly, at a soil moisture of 30.5%, the potential production yielding will reach 85%.

ISSN: 0975-8585

CONCLUSION

Test investigations have shown that the efficient soil decompaction by frost action at a soil bulk density of 1.1 to 1.4g/cm^3 is ensured by soil moisture being at least 28%.

The essential moisture content level can be ensured by creating soil conditions that allow holding precipitation moisture at a site of precipitation. It isimportant to ensure precipitation moisture absorption by the soil and minimize the loss of moisture while evaporating from the soil surface, at the same time partially retaining the capillary network that would raise moisture from the lower soil layers to the freezing front.

To forecast yielding capacity of cultivated crops on the soils with different fertility levels, where a technology ensuring soil decompaction by frost action had been implemented, the above-mentioned express method with a sufficiently high level of reliability can be used to determine the soil productive capacity at its real moisture content and bulk density parameters.

REFERENCES

[1] Cherepanov, G.G. Compaction of arable soils and ways to eliminate it / G.G. Cherepanov, V.M. Chudnovskykh. - M.: VNIITE Agroprom, 1987. - 58 p.

[2] Skvortsova, E.B. Seasonal dynamics of the structure of pore space in arable horizons of grey forest soils / E.B. Skvortsova, P.M. Sapozhnikov // Pochvovedenie. - 2002. - No. 3. - P. 319-326.

[3] Saveljev, Yu. A. Increase of soil decompaction efficiency by using autumn shallow strip tillage: monograph / Yu.A. Saveljev, P.A. Ishkin. - Kinel: EPC SSAA, 2017. - 158p.

[4] Saveljev, Yu.A. The process of frost actionon the soil effecting its decompaction and soil productive capacity / Yu.A. Saveljev, P.A. Ishkin // Bulletin of the State Medical University of Ukraine - 2009. - №2. - P. 137-140.

[5] Saveljev, Yu.A. A technique of estimating the degree of soil decompaction by frost action, depending on soil moisture and bulk density/ Yu.A. Saveljev, P.A. Ishkin // Izvestija Samara State Agricultural Academy. - Samara, 2007. - Issue. 3. - P. 19-20.

[6] Kukharev, O.N. The technical solution for a laminated coating on a rounded surfaces / O.N. Kukharev, I.N. Semov E.G. Rylyakin Contemporary Engineering Sciences. 2015. T. 8. № 9. C. 481-484.

[7] Nugis, E.Yu. Methodical recommendations on express diagnostics studies of integrated assessment of mobile implements running systems exposure on the soil / E.Yu. Nugis, E.A. Reppo. - Moscow: VASKhNIL, 1984. - 24 p.

[8] Kukharev O.N. The technology of obtaining high-quality seeds of sugar beet / O.N. Kukharev, A.V. Polikanov, I.N. Semov // Research Journal of Pharmaceutical, Biological and Chemical Sciences, 2017 – T. 8. № 1. – C. 1210-1213.