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THE EFFECT OF SOIL COMPACTION ON WATER BOUNDING ENERGY

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The level of mechanization of agriculture has become very high recently. Its index can be the number of tons of machines per one ha. The application of more and more heavy machines and vehicles (with the sim of increasing their power) has a significant on the soil compaction. A great number of experiments concerned with volume deformations of soil caused by cultivating machines, which has been recently published in the world, gives and evidence of the importance of this problem. These experiments concern mainly the value nad the duration of applied stresses on the volume deformations [1, 9]. Much attention is particularly paid to the effect design of wheels and caterpillars and their speed rate on the soil condition at various values of its moisture content. The result of these experiments are numerous practical conclusions concerning, among others, limitation of machine traffic, achieved by combining the cultivating machines, the necessity to utilize caterpillars on some particulary moist soils in order to reduce the effect of soil stresses. Furthermore, it is necessary to devote some attention agrotechnical implements at low moisture content in soil [2, 9]. The basic research on the volume deformations of soils are concerned among others with determination of the energy spent on the volume deformations [3] and the speed of deformation wave.

The research on the evaluation of the effect of mechanical soil compaction on its water-air relations, has been carried out in two directions:

1. Direct investigation on the effect of soil compation on plant growth [7, 8].

2. Fundamental investigation concerning porosity, pote distribution, the diffusion of oxygen, changes of static and kinetic water conditions which depend on soil compaction [4, 10].

The studies, carried on by the author, dealt with the influence of the soil compaction on the energetic state of water in soil. The research was carried out on two kinds of soil: the brown soil composed from loess and chernozem made from heavy loam with a disturbed structure (sift through a 1 mm sieve). 2—3 mm thick soil layers were subsequently compacted in cylinders. During the compaction process humidity of brown soil amounted to 20% and the chernozem amounted to 30%. The ranges of unit weights were (A) — $1.425—1.700 \times 10^3$ kg m^{-3}, for brown soil and (B) — $1.175—1.655 \times 10^3$ lg m^{-3} for chernozem.

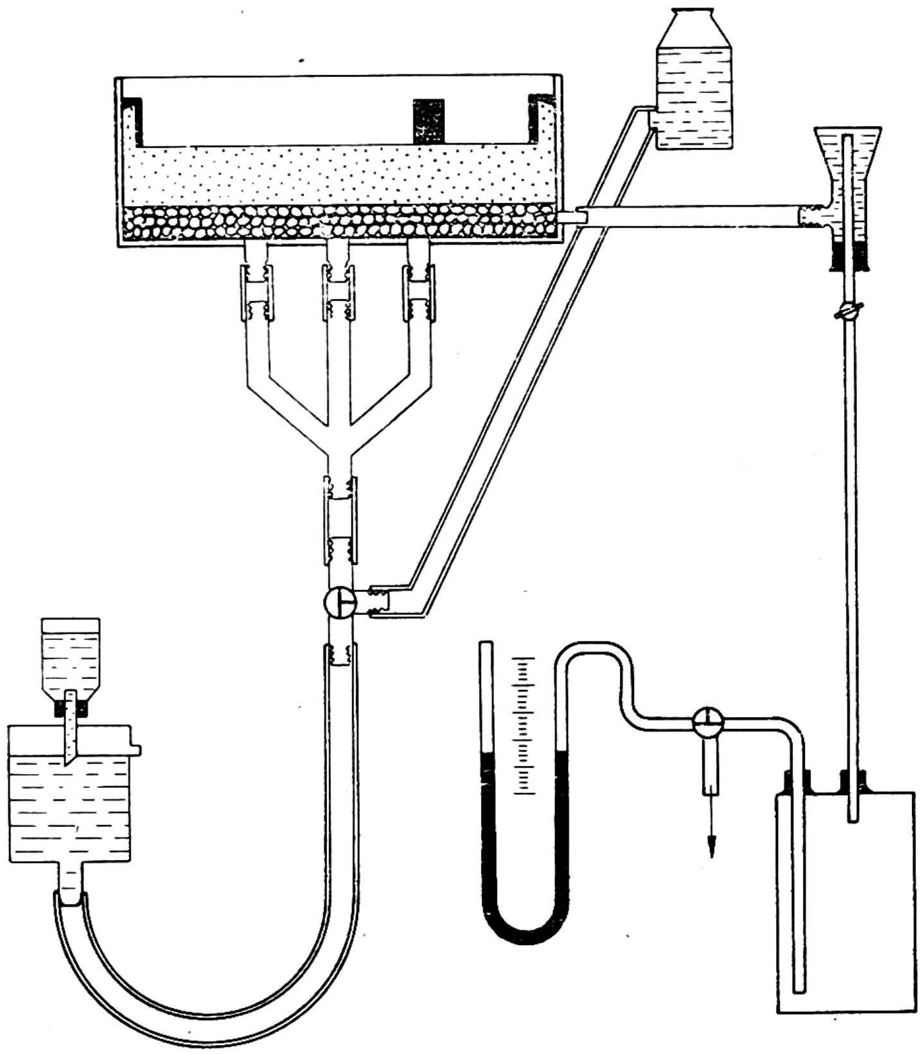
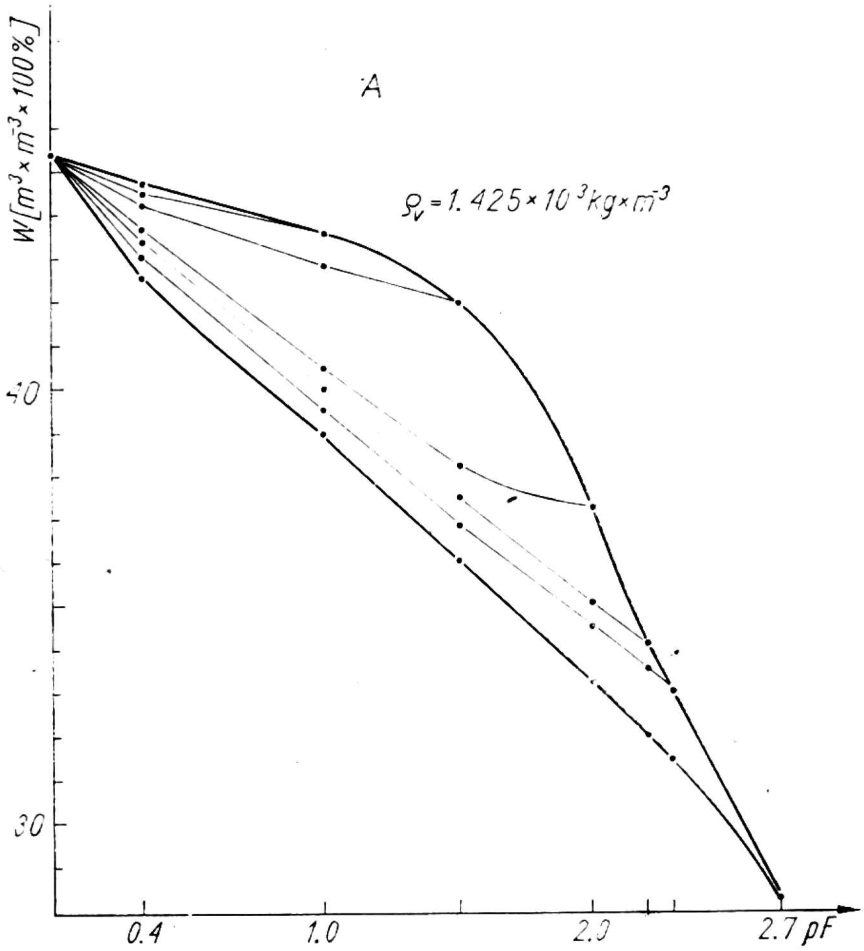


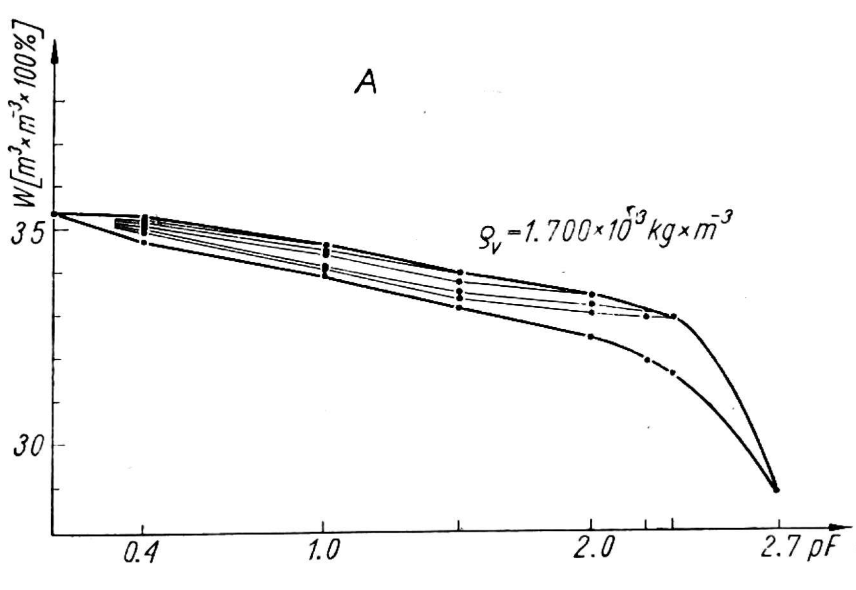
Fig. 1. Apparatus for PF-curves determination

Water suction characteristics in the range of pF from 0 to 2.7 were obtained by the use of specially constructed apparatus designed at the Institute of Agrophysics PAN in Lublin (Fig. 1), whereas for pF 3.4 the results were obtained in pressure chambers according to the method of Richards in Academy of Agriculture in Lublin.

The pF-moisture curves were drawn not only in the drying process but also in the wetting process, what is the development in contrast with the previous studies. These two processes are irreversible thermodynamics processes and so they give a histeresis effect. Some of the obtained results are presented in Figs. 2, 3.

As a result of the performed search it was stated that the histeresis effect for wetting and drying processes is considerable especially in small compations. In order to describe exactly the energetic state of water in soil and to predict, both teoretically and practically the water transfer in soil, it is necessary to take into consideration the histeresis phenomenon. To interpret the obtained results the domain theory of histeresis was





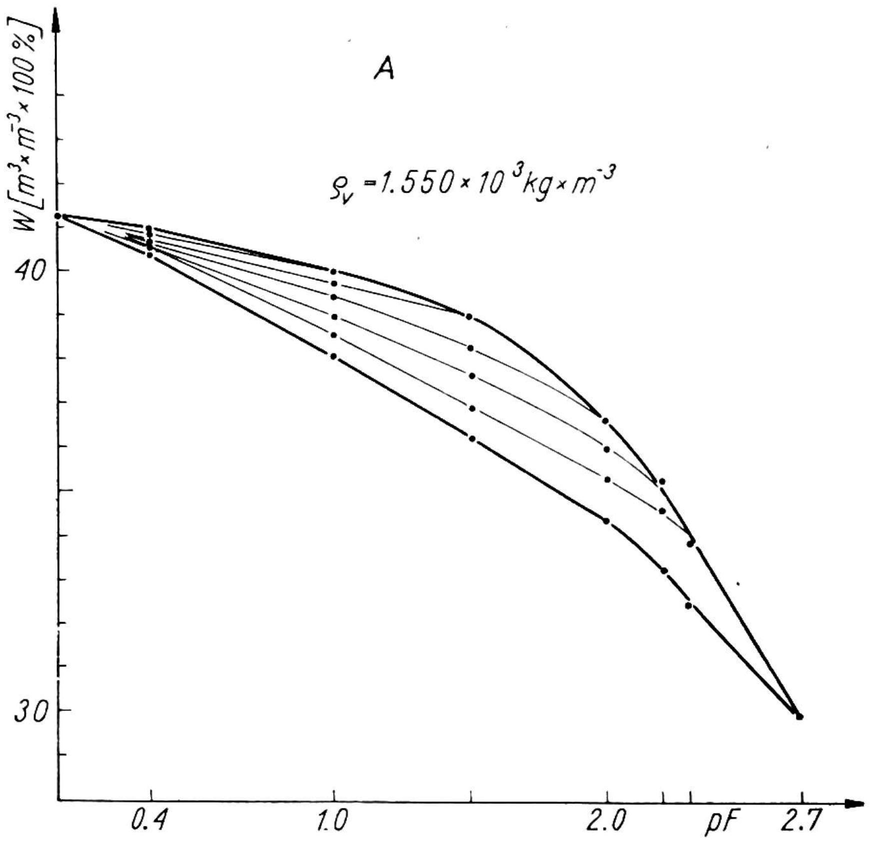
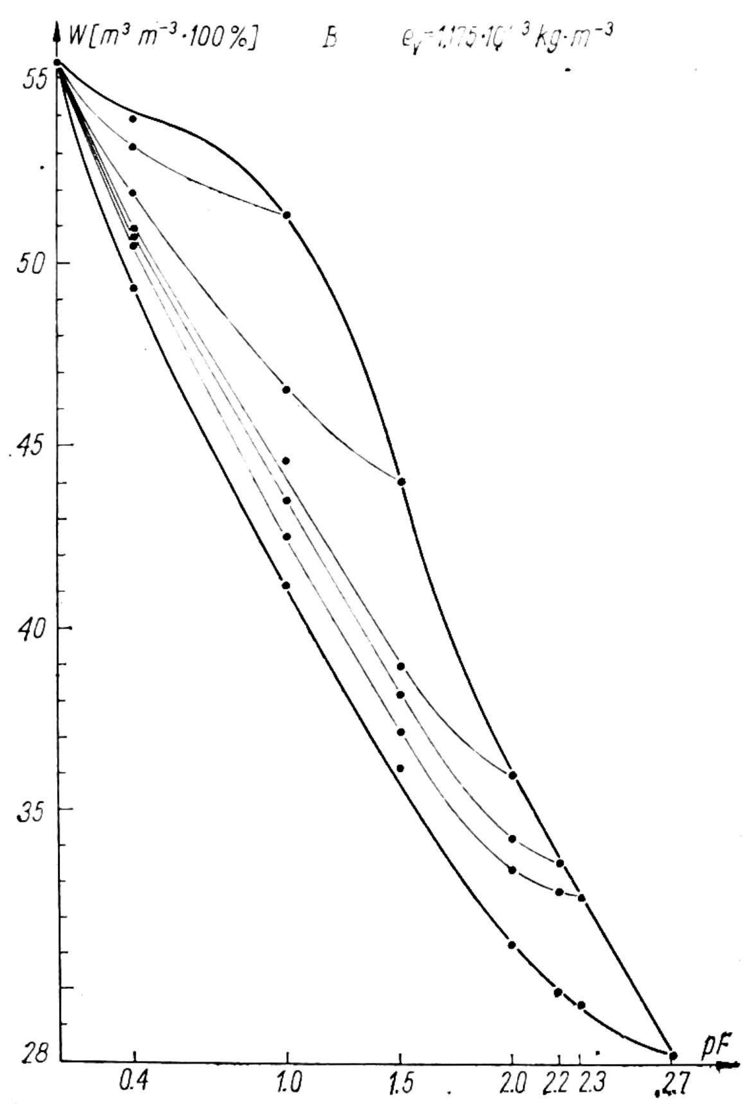


Fig. 2. Hysteresis loops for chernozem of different compaction



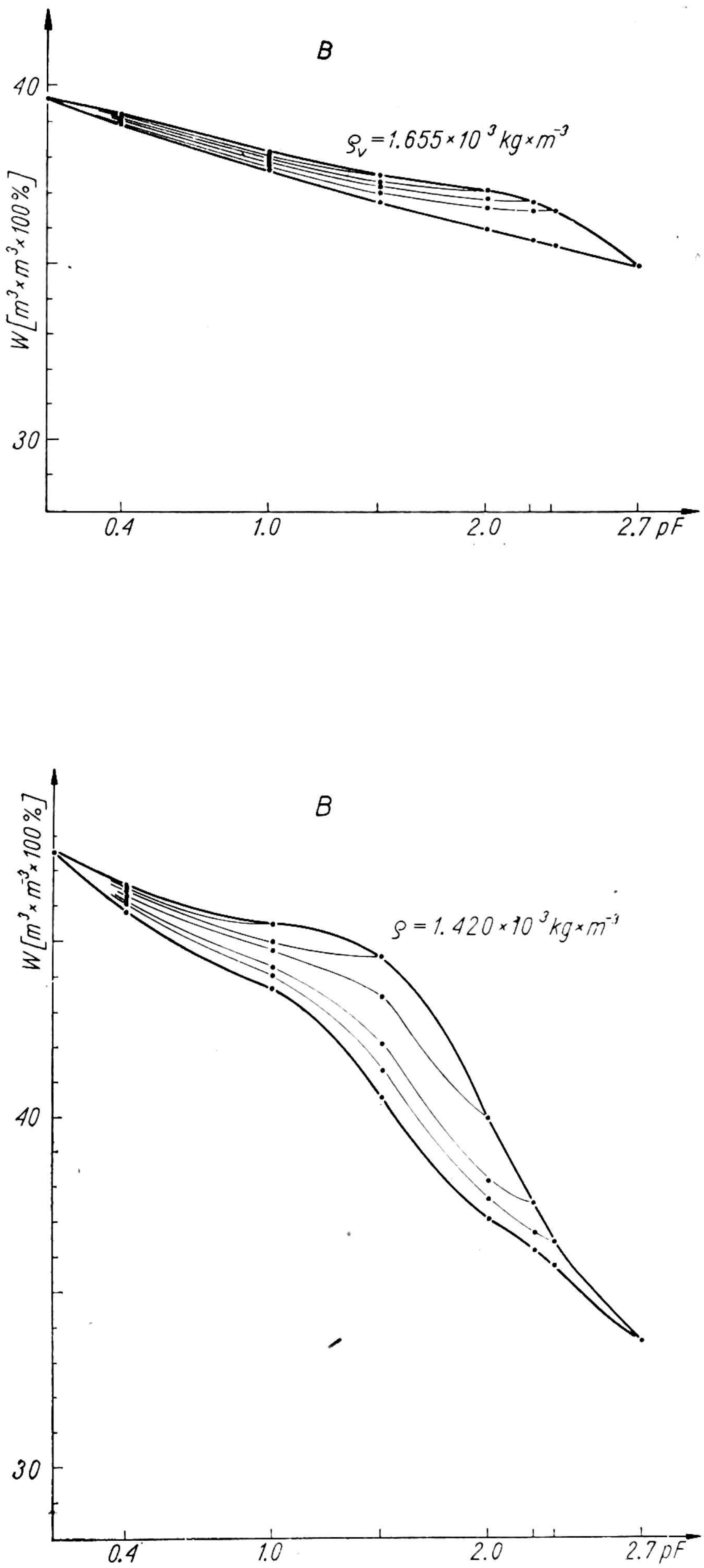


Fig. 3. Hysteresis loops for brown earth of different compaction

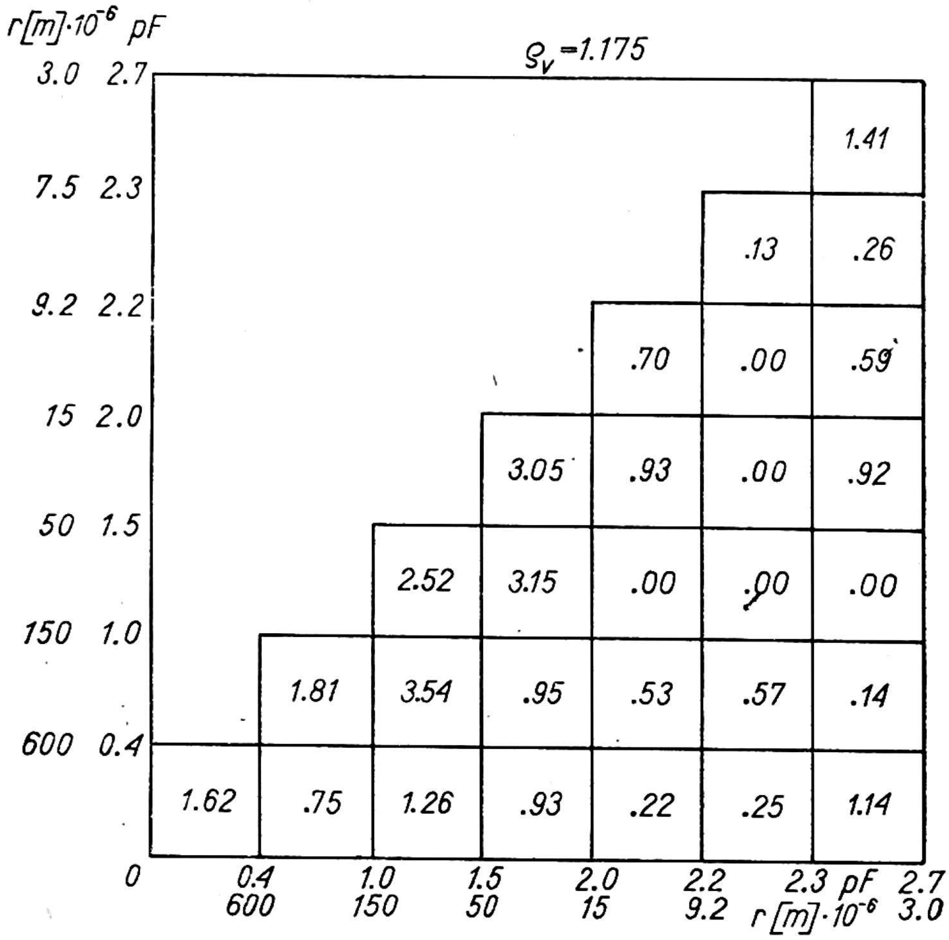


Fig. 4. Distribution diagram

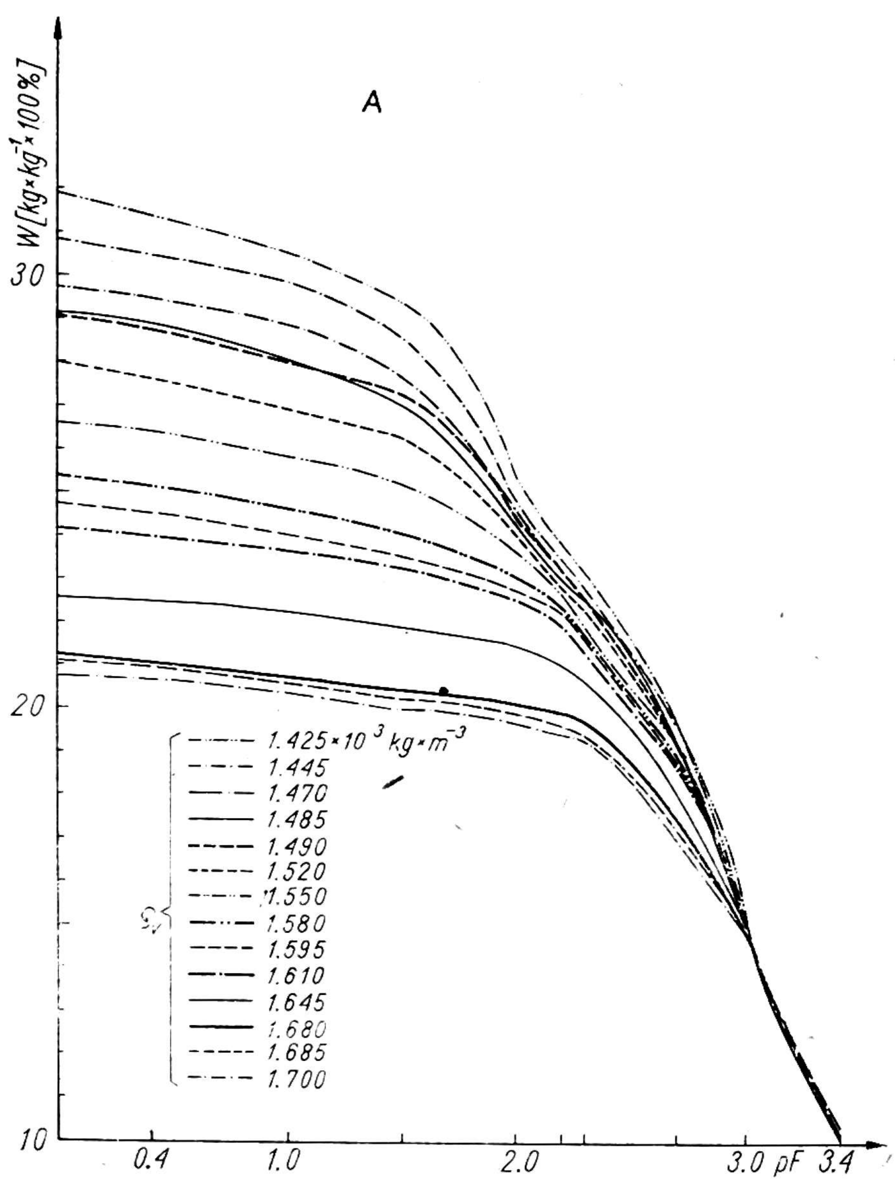


Fig. 5. Bonduary drying curves for chernozem

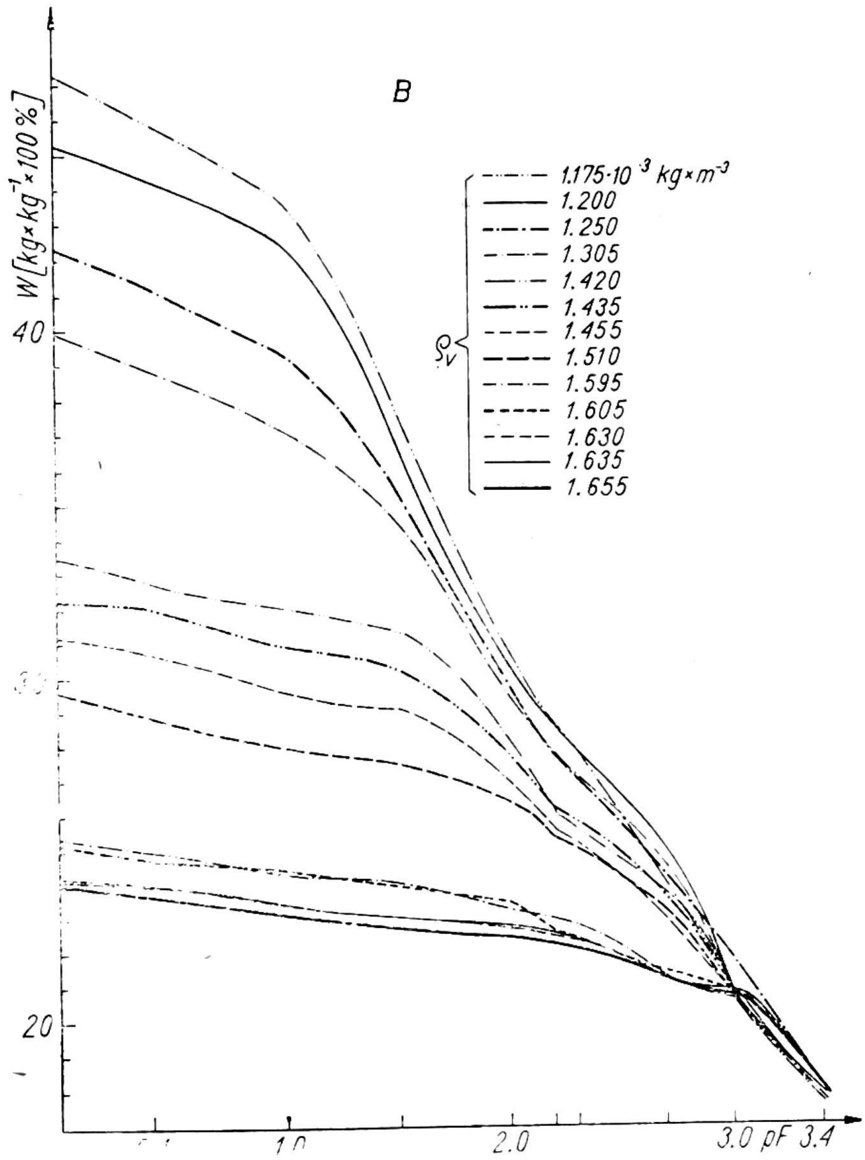


Fig. 6. Bonduary drying curves for brown earth

used [6]. This theory enables to predict the behaviour of the system after arbitrary changes of suction pressure on the basis of the knowledge of bonduary curves of histeresis loop and the primary scanning curves of wetting process. Making use of this theory it is also possible pores distribution, describing their geometry by two radii: the minimal radious r and the maximal radious R, describing the pore volume of the radii ranging from $(r + \Delta r)$ and $(R + \Delta R)$, respectively.

A numerical method has been developed at the Institute of Agrophysics PAN to calculate so-called diagrams of distribution. An example of such a diagram is shown in Fig. 4. On the basis of a diagram it is possible to determine the amount of water which is drained from the sample at the moment of increase of sucction pressure or supplied to the sample at the moment of decrease of suction pressure. The main curves of drying are presented in Figs. 5, 6. From the plot it can be seen, that the amount of water available for plants, i.e. pF 0—3, decreases considerably with the increase of mechanical compation.

It is due to the decrease of the number of pores of greater diameters. The decrease of the number of pores, along with the increase of unit weight causes a remaible disturbance of airwater conditions in soil.

Precise, quantitative results of the experiments are now being interpreted, and that is why only general conclusion have been presented in this paper.

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WPŁYW ZAGĘSZCZENIA GLEBY NA ENERGIĘ WIĄZANIA WODY

Streszczenie

Przedstawiono aparat do wyznaczania krzywych pF skonstruowany w Instytucie Agrofizyki. Pomiary wykonano na próbkach gleby lessowej i czarnoziemu zagęszczonych sztucznie. Pokazano, że zagęszczenie mechaniczne wpływa na energię wiązania wody do pF = 3,0. Związek między potencjałem wody a wilgotnością został zinterpretowany przy pomocy domenowej teorii histerezy. Podkreślono, że wyznaczanie krzywej brzegowej dla osuszania jest niewystarczające dla wodnych charakterystyk gleby, szczególnie w przypadku małego zagęszczenia. Wydaje się, że w opisach transportu wody w glebie powinna być uwzględniona histereza.

Р. Вальчак

ВЛИЯНИЕ УПЛОТНЕНИЯ ПОЧВЫ НА ЭНЕРГИЮ СВЯЗЫВАНИЯ ВОДЫ

Резюме

Описывается аппарат по определению кривых pF, построенный в Институте агрофизики ПАН. Измерения проводились на ускусственно уплотненных образцах лёсса и чернозема. Установлено, что механическое уплотнение оказывает влияние на энергию связывания воды до pF = 3,0. Связь между потенциалом воды и увлажнением интерпретируется с помощью доменной теории гистерезиса. Подчеркивается, что определение граничной кривой для осушения недостаточно для водных характеристик почвы, особенно в случае небольшого уплотнения. Представляется необходимым учитывать гистерезис в описаниях транспорта воды в почве.