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NON-CONVENTIONAL SIGHT AT PARAMETERS OF OPTIMUM STRUCTURE OF ARABLE LAYER

The purpose. To inform about results of own researches and reflections concerning opportunities of physical parameters of soil by means of measures which in the core remain without attention or are evaluated negatively. Special attention is given to an opportunity of optimization of water regime. **Methods.** Field, laboratory-field small-plot experiments, laboratory researches. **Results.** Essential influence of cloddy and fissured structure of soil on physical and agronomic soil characteristics and availability in field and space localization of organic mass of the postharvest remnants of different structure of mineralization is fixed, as well as features of influence of micro-relief of surface of a field upon heterogeneity of density of soil in connection with size and quality of yield, in particular tuber crops, and facts and conditions of development of positive influence of cloddy and fissured constitution of arable layer upon secure with moisture and productivity of field crops. **Conclusions.** Use of subsoiling technique secure saturation of the upper (sowing) layer of soil with organic mass of postharvest remnants which changes its agro-physical and agronomic properties, prevents formation of surface crust and depending on crop and period of sowing influences field germination rate of a crop.

Key words: density of soil, postharvest remnants, micro-relief of field, cloddy and fissured structure, water regime.

Formulation of the problem. Achievements of agronomic physics, prevailing domestic and foreign schools of soil sciences, provided the development of main sections of scientific agriculture such as soil tillage, soil conservation, irrigation farming, agricultural mechanics.

In this regard it should be noted contribution to the development of this section of knowledge Kharkiv school of soil scientists in the person of V. Medvedev and his colleagues towards argophysics [1, 2, 3, 4]; V. Gordienko problems with water soil treatment – Uman School of agriculture [5]. The latest

Russian media note is the fundamental book "Theory and Methods soil physics", edited by E. Shein and L. Karpachevsky [6].

In early statement of our position, formulated in the title consider it appropriate as a kind of reference point choose the classic work of V. Medvedev "Variability of optimal parameters of the factors influence it and soil density ". It fully outlines factors that determine the variability of this indicator. These include: soil type, mechanical composition crops, variability in time, spatial variability, ecotrophic variability (dependence caused by moisture and mineral nutrition) [7].

The first two of the aforementioned factors, in segment observation time is unchanged. Other factors may be changed by agricultural technologies.

Methods and results of research. Spatial variability formulated as differentiation optimal parameters in parts of the layer of withdrawal in horizontal and vertical directions. This is closely associated with the of soil tillage technologies.

From this perspective a considerable amount of research were carried out in the field microplot experiments or in vitro. At the same time, the question of the problem variability of optimal soil physical parameters in real field conditions given insufficient attention. This includes finding out the reasons that cause them, but mainly methods for assessing the physical condition on separate fields there are lot of large number of different macro and mikrozon. Getting the average indices indicate little about that.

It is necessary to take into account the conditions of the field for the most part are very different from those that can be reproduced in microplot, especially in experiments in vitro.

The feature microplot and , experiments in vitro is to extract a soil sample from the environment in which it is formed. Thus for the purity of the experiment it largely freed from organic impurities of plant residues at different dimensions at different stages of decomposition. Further studies are the subject of soil aggregates under different their spatial distribution and packing. Such an environment is, to some extent, artificial, "sterile".

Given the intensive farming dry weight of straw, stems and root residues left in the field after harvest is considerable and according to our record in one of the farms in the Right-bank Forest Steppe Kyiv Region is per hectare of arable land, soybean – 6, 06 tons, of winter wheat – 11,5 tons, of spring barley – 11,7 tons, of winter rape – 5,4 tones. It is necessary to allocate maize at an average yield of 10 t/ha the dry weight of post-harvest residues is 21,6 t/ha. Its incorporation into the soil could significantly affect the water-physical and therefore on agronomic soil properties especially for its location in the upper 5-10 cm layer or on its surface. Their influence is especially noticeable on light soils with a significant share of sand fraction. This object – sod-podzolic sandy-loam soil with sand contents fraction – 88% physical clay – 12% and humus – 0,9% was in our field of scientific interest for 23 years in research programs of tillage in the area of Polesie [8].

Research Programme formed around a stationary field experiment (1972 - 1995 years.). Which in nine-fields crop rotation: winter wheat, potatoes, oats + clover, clover, flax, winter wheat, corn silage , winter rye) tested 14 soil tillage systems. Of these three options block (plowing, sweep loosening and shallow cultivation by discs) has been studied in three backgrounds of fertilization.

Already in the first years of research interest in the properties determined the top 5 - 10 cm layer was seen as a positive influence nonmoldbord sweep and disk cultivation on starting conditions for some in crops rotations.

The logical assumption was that the impact of localization in this layer organic matter of post-harvest crop residues and organic fertilizers. Determination of theirs organic mass in fields of winter wheat and potato showed a significant withdrawal in the distribution of these indicators in the profile of topsoil by plowing and disking (Tab. 1).

Traced the inverse relationship between the of soil density and volume of organic residues, washed from the soil sample. This dependence is less obvious to layer 10 - 20 cm. The general trend indicates a higher density in this layer by discing cultivation. The correlation coefficient between the density of the soil in

the fields of winter wheat and potatoes during growing and the sum of volumes of post-harvest residues of precrops is 0,8, 0,85 respectively.

Table 1

Soil density, volume and mass of post harvest residues of precrops and manure spring time in field of wheat winter and before planting potatoes

Soil cultivation	Soil layer	Winter wheat, precious crop lupin			Potatoes precious crops winter wheat, manure 40 t/g		
		soil density, g/cm ³	mass of washed residions	volume of washed residions	soil density, g/cm ³	mass of washed residions	volume of washed residions
Plowing	0-10	1.57	0.5	4.2	1.58	0.4	2.1
	10-20	1.56	1.1	4.6	1.53	0.6	2.8
Discing	0-10	1.49	1.1	7.1	1.42	1.8	6.5
	10-20	1.59	0.3	3.6	1.60	0.6	2.8

Our results, this coincide with the data obtained on the soil of the same type by V. Strelchenko [9].

In order to clarify the impact of post-harvest residues to acquire resistance to soil compaction was conducted in vitro experiment by the use Vesiliev's device.

Samples of air-dried soil with a previously set density of 1,30 g/cm³ was subjected to capillary moisture and drying to the original condition. Along with these samples added a different mass of post-harvest residues of winter wheat, linked to data from a stationary experiment.

Table 2

The density of sod-podzolic sandy loam soil under conditions of capillary wetting and drying

Treatment	Previously set soil density, g/cm ³	Mass of crop residues, g/cm ³	Soil density after circle of wetting and drying g/cm ³
1	1.30	Без залишків	1.57
2	1.30	0.4	1.59
3	1.30	1.2	1.49
4	1.30	2.0	1.46
5	1.30	2.8	1.43
HIP_{0,05} g/cm³			0.03

Data obtained in vitro indicate soil compaction in the absence of plant residues – up to 1,57 g/100sm³. Their presence in the soil becomes noticeable by weight of 1,20 g/100sm³ and reduced to 1,43 g / cm³ for the mass of 2,8 g/100sm³.

Longing foregoing should be considered that structureless sod-podzolic sandy loam soil, consisting mainly of primary particles, along with loosening and compaction associated with tillage technologies significant role in shaping their physical regime belongs to the mass and volume of post-harvest residues, their localization in profiles of processed layer. This effect is most noticeable on sweep or disk cultivation in the top 10 cm layer where localized volume of organic residues roots.

In terms of field stationary experiment arable (0-20 cm) layer of soil in a field of potatoes left without plants compacts up to 1,48 g/100sm³. Plants are installed on the equilibrium density level of 1,40 g/100sm³. All agronomic measures were identical. [8]

The most notable result of the presence in sowing layer of post-harvest residues in surface soil layer is seed germination.

The characteristic is a reaction to the events cultivation of seeds germination of winter and spring crops. Plowing provide the best conditions for winter crops compared with disking. For winter crops are important terms of harvesting collection and mass post-harvest residues of predecessor. The minimum difference in the germinate capacity of winter wheat sprout between these options is after flax, a plants of complete remove from soil. Maximum, for plowing, it is observed in a field of winter rye after corn. The latter leaves the greatest mass of organic residues and collected immediately before sowing. For all spring crops best conditions for germination created by disking.

Table 3
Field germination sprouts in crop rotation by plowing and disking, pcs./m²

Basic tillage in crop rotation	Precrops					
	lupin	flax	corn for sil.	clover	potato	winter wheat
	field crops					

	winter wheat	winter wheat	rye	flax	barley	fodder beet
Plowing 18-25 cm	438	375	285	1393	370	8,9
Discing 10-12 cm	397	364	227	1582	400	13,1

For the winter crops localization seeds after disking or background of fresh not decomposed residues worsens condition for germination.

At spring half-decayed residues of precrops provide extra moisture seed layer, prevent compaction and soil crust formation. This state of the surface layer of soil in the spring clearly recorded visually.

Among the investigated crops the most sensitive to positive conditions, composed by disking proved fodder beet.

This feature of the crop, were the basis for the elaboration of original technology adapted to sandy loam soils in which plowing replaced by disking 8-10 cm. The main goal was maximum al saturation seeds (3-4 cm) layer by post-harvest residues of precrop – winter wheat and manure. Two basic afore mentioned tillage technology, manure 40 per hectar and fertilizers in dose N₂₀₀P₁₂₀K₂₀₀.

The sprouts density after plowing and disking was respectively 4,8 and 6,7 units. per meter. Before lifting 3,5 and 5,0 units. The yield by plowing and disking was respectively 94 and 108 t/ha [11].

In course of development in different areas Polissia farms became clear possibility of growing this crop not only in sandy loam soils, but on sandy soil where receiving was of sprout was generally problematic.

The results also show specific reaction fodder beet on small depth basic soil cultivation probably due to the fact that, unlike the sugar beet this crop forms its productive roots mostly above surface.

Based on the above, the factors of spatial variability of the optimal density of the soil should also include a presence of post-harvest residues, their localization within the treated layer.

From the standpoint of the need for further development of the theory of soil cultivation can assume that a certain density of soil can be formed by aggregates of

different sizes and the its compaction. In turn, it is similar magnitude may be due to different mass ratio formed by the actual soil particles of soil and organic residues of various degree of mineralization. Agronomic properties of soil, especially for seed layer in such a formally equal density value will be different.

This is especially important due to the peculiarities of modern intensive farming, when all above soil surface crop residues crushed and spread on the surface of the field. Further, it can be incorporated into the soil or left on the surface as a mulch for "zero" cultivation.

In spatial variability ratio and its stability over time significantly affect by elements of field microrelief. Any surface curvature associated with natural processes, but most of technological factors stipulate manifestation of the effect of "dome". Formed during rainfall soil crust forms on the surface solid structure. During a long time under such "arch" can be kept much lower density than the flat surface. This zone under a crust usually is in the form lenses (Figure 1a).

On the basis of this effect the technology of potato grooving has been elaborated. The main deterrent was the ridge in any case not recommended subjected to mechanical cultivation. Weed-control carried out exclusively by using herbicides.

These dome-shaped on structures sandy-loam soil are stable under crops canopy. Without plants this effect may be short-term.



Figure 1 – The effect of the "dome" for growing potatoes

1. Soil crust (dome) of soil density $1,50-1,55 \text{ g/cm}^3$

2. Lens loose soil under the crust with a density of $1,30-1,35 \text{ g/cm}^2$

3. Arable layer of soil density of 1,46-1,50 g/cm²

For self-consolidation of the soil at their main and preplant soil density in drawing up the ranks set at 1,42 g/cm³ to crest 1,31 g/cm³. When hitting to the emergence in the row wheel tractors class 1,4 tons of soil density increased to 1,60 g/cm³. In time of lifting soil sefloosened down to 1,50 g/cm³. This yield is reduced by 30%. Changing the density of the soil within 1,31 g/cm³ and 1,42 g/cm³ for performance crop culture is not affected.

However, between density of soil and crop quality there was a close connection. With the density of 1.50, 1.42, 1.31 g/cm³ tuber scab infestation of the respective 98, 54 and 13%. Furthermore tubers under the "dome" were typical of the sort of form preparation.

Due to the natural and spatial heterogeneity of topsoil structure, and technological factors especially determined to question the methodology of sampling and especially the interpretation of the results. To obtain objective data on the state of the field required a significant number of sampling points or measurements requiring considerable physical effort and time. Getting averages can hardly characterize the influence of heterogeneity of soil structure on the productivity of crops.

Another problem is agronomic evaluation lumpy, fissured soil structure. This it's his state is perceived as negative and mostly temporary, especially with regard to primary tillage.

After fall basic tilling, after several cycles of freezing and thawing soil by preplant tillage tools prepares to condition favorable for germination.

Nevertheless with the lumpy and fractured soil wee constantly have to deal with in daily practice agriculture, not only from a clearly negative phenomenon.

Drought necessarily accompanied by the appearance in soil cracks. Evaluate past quite negatively not necessary. During intense rainfall possible they quickly absorb a significant amount of water and provide instant translation it from horizontal flow to vertical drain in to the lower layers of soil.

With the formation of large cavities in the soil related widely recommended in conservation soil agriculture artificial cracking of fields and winter crops in the reclamation practice.

Recently, the market appeared sowing coulters of Western European production units which provide for the formation of cracks at sowing seeds and placing them near of it. This gap in both pneumatically rush fertilizer. In this case cracking acts not as reclamation, and most likely - farming practices.

Lumpy, fractured structure beamed of the object of our scientific interest for the development and implementation of two-steps technology tillage for potato cultivation on sod-podzolic soil since 1986. Further, these studies were extended to other field crops and soils [8].

The feature of this technology is the separation process basic soil in two stages (phases). The first of these involves shallow cultivation to ensure favorable natural conditions for seed germination. At this stage, the required physical parameters of the seed layer completely relevant essential requirements set out in the scientific and educational literature, recommendations for extention.

The second stage (phase) is sweep deep loosening after planting at a time when the seedlings have formed the stairs or in the early stages of its organogenesis they become available. The basic tillage in this case is not made before sowing but after.

Its main hypothesis is reduced to the assumption of different requirements plants to the physical condition of the soil at the starting point, mainly before the germination, and postplanting vegetation . It, in turn, incorporated in the dual nature of the plant organism, which appears in two basic forms - seeds and vegetative plants.

For deep lessening (maximum of 25-27 cm) before – germination the soil formed lumpy, fractured structure. Nevertheless, the majority of field tests on the such structure field crops responded positively. Increase productivity was within 8-10 to 30-40%.

Related observations in experiments found a significant increase in soil moisture content versus fixed the control. Additions of available moisture contents in meter layer of soil was between 14-20 to 36 mm.

These phenomena are explored extremely insufficient. In this regard, we believe that it is this feature deserves the most attention.

In agriculture and at the same time in soil science lumpy, fractured structure of topsoil, is not among the actual objects of study for obvious reasons.

First of all, such structures can not provide high field germination of seeds. In modern terms this shortcoming largely be eliminated by technical measures.

An important caution regarding lumpy structure is a sharp increase in convective diffuse loss of moisture. This is a firmly established fact. Our research confirms it. Indeed, after separation, lumpy, tracted laye from soil monolith it is established unstable water regime. Moisture in it drastically reduced. However, its overall in balance in meter layer is in favor for lumpy, fractured structures.

The phenomenon fracturing could not ignore by A. Budahovsky in the book "Absorption water in the soil." The author observed cracks opportunity to influence the formation of ground water regime [9].

At the same time he expressed a temporary theirs impact on the water regime cracks of the soil. But during the growing season, because with it balance moisture al and swell, these noted cracks emptiness liquidated.

In our studies, we do not observe so Lumpy, fractured structure of topsoil created artificially kept during the growing season, even on structureless sod-podzolic sandy soil containing 12% physical clay (Figure 2).



a

b

Fig. 2 Structure of topsoil in the field of conventional potato (a) and two-steps (b) cultivation.

The picture made at a time when the aerial mass crop was completely formed. Reported topsoil structure was kept until the time of lifting. The differences between our observations and opinions expressed in the aforementioned work is related to the difference between considered objects of external similarity.

Obviously, in the first case it is solely the natural phenomenon of formation of cracks on drying the soil. After its moisture absorption and swelling cracks are closed and monolithic soil is restored.

Where such a ground structure formed as a result of mechanical tillage for moisture loss amount of individual structural elements is reduced, and the volume of cavities can grow. When moisture layer with the structure and output volume swelling soil cavities restored it. Obviously also affect the downward movement of water in the form of preferential flow in which a large part of the surface layer is not delayed.

The stability of these structures is supported at this time by developed root system and aboveground mass of plants.

The properties of such structures is difficult to assess by existing methods accepted in agriculture. It's hard to find a mathematical relationship between the state of soil and crop productivity.

The properties of the soil are changing discretely. It contains soil monolith with its own structure. The latter can be assessed by standard methods. At the same time it takes a significant amount of large cavities, which can change the properties of the system. In addition, it is a component of plants with their aerial parts and roots.

Our results are easy to experimental verification and enable all concerned to give them may be a more proper, adequate explanation.

We believe that the bulk of the researchers did not notice or insufficiently rated appearance in the practice of domestic agriculture a new class of units - drills to implement without sowing preplant mechanical cultivation.

The last farms are widely used them not only for the introduction of technology "zero" tillage, but also after plowing, disking, sweep loosening, heavy cultivation's. For all these basic cultivation by the use of such drills preplanting cultivation is not made. Preparation the soil for sowing is done by sowing unit.

Under such conditions the range states are allowed to bend before sowing significantly expanded. This is especially true for now crops. For their cultivation zone area for seed placement and spacing zone may have a ratio of 1:30. Requirements of plants to their physical parameters may be different. In particular, the first responsible for obtaining the stairs, and the second mode for formation moisture regime of fields.

As noted above, the ability to use positive lumpy, fissured soil conditions we found in experiments on subjects two-steps technology. This idea has not received wide practical implementation and obviously will not get it. Too many in this scheme of technological and organizational precautions.

However, experimental data, obtained during these studies, can extend the idea of the range of the physical parameter, which may be attributed to optimal. Therefore, the two-steps principle can be used to develop other advanced technologies, especially for regions with heavy water regime or the conditions of irrigation to save water resources.

In connection with the above, we believe it possible under certain conditions, to evaluate lumpy-fractured state of topsoil as favorable for the formation of high performance field crops.

Unfortunately, this state of the soil can be assessed in terms of density, hardness, agronomically valuable structure, and an air permeability. It is a separate object, which is waiting for the manifestation of greater interest to him.

Conclusions

1. In a large mass of intensive agriculture post-harvest residues left in the field on the surface of the soil or earned various instruments cultivation. Their influence on the physical properties of the soil, especially in sowing layer appreciated not

enough. The latter requires attention to the physical properties of mixtures of soil aggregates with a mass post-harvest residues different degree of mineralization.

2. Heterogeneity of soil density is largely determined by the natural or artificially created micro, particularly the effect of "dome". The latter can be used specifically in the technology of growing certain crops.

3. Development of technology cultivation and sowing requires reassessment ideas about optimal parameters regarding the structure of the topsoil before planting and during the growing season. From this perspective lumpy, fissured structure of the soil may, under certain conditions, contribute to improving soil moisture regime and increase the productivity of field crops.

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