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Agro-physical properties of darkchestnut soil at different systems of basic cultivation and fertilization on irrigated lands

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The purpose. To determine agro-physical properties and water regime of soil at different systems of basic cultivation and doses of fertilizers, to calculate the level of yield of crops and productivity of crop rotation. **Methods.** Field and mathematical analysis. **Results.** Subsoiling systems of basic soil cultivation, and irrigation water form agro-physical properties which are optimum for growing winter barley and partially meet demands of corn and soya bean. Use as fertilizer of all collateral products of crops and increase of rate of application of nitrogen fertilizers from 75,0 up to 97,5 kg/hectare d.w. counting for 1 hectare of crop rotation square with inoculation of seeds of soya bean by Rizogumin promoted increase of productivity of crop rotation for 15,0 – 16,3% c. units according to systems of basic soil cultivation. **Conclusions.** In the tilling crop rotations on dark-chestnut medium-loamy soils in conditions of irrigation in the South of Ukraine it is expedient to apply system of the differentiated-1 basic cultivation with use as fertilizer of all collateral products and enter fertilizers in dose N97,5P60. That will ensure profit at the level of 10 thousand hrn/hectare, and the level of profitableness 110%.

Key words: method, depth, dose of fertilizers, firmness of build, water permeability.

One of the areas of reducing the cost of agricultural production is to minimize the main cultivation by reducing its depth, multiplicity of passages units or replace more energy-intensive cultivation with rotation chunks, less expensive - without rotation chunk. The introduction of the following methods of minimizing significantly reduces energy, labor, material and cash costs of production in the crop rotation on irrigated land [1, 2, 3, 4, 5]. In this context, the relevance of the developed theme is the need for scientific substantiation of the possibility of the use of surface and shallow subsurface soil treatment in combination with irrigation systems, fertilizers and plant protection products. However, the application of minimum tillage in agriculture is still controversial, and one reason for this is the data inconsistency With regard to its impact on the agro properties, nutrient status, phytosanitary condition and productivity of farmed crops.

Considering that in the market conditions, the end result is to obtain a high income, the farming systems on irrigated land should be based on the optimization of material and energy costs and to obtain the highest level of profitability of cultivation culture.

The purpose: the definition of indicators of agro-physical state and water regime of soils of different systems of main tillage and doses of soil fertilization; establishing the level of harvest of agricultural crops and productivity of crop rotation.

Research methods. In the stationary department experiment of irrigated agriculture on the lands of the experimental farm of the Institute of irrigated agriculture NAAS of Ukraine during 2011-2015, 4-pole link of

crop rotation on dark chestnut medium loamy soils in range of Ingulets irrigation systems studied five main tillage systems, which differed between a depth of loosening, the costs of non-renewable energy to carry them out and tested four doses of nitrogen fertilizers.

Factor A (cultivation):

1. The system of midwater moldboard treatment;
2. The system of midwater subsurface treatment;
3. The system of still shallow depth disk treatment;
4. The system of differentiated tillage with another slotting on 38-40 cm in crop rotation;
5. The system of differentiated tillage in crop rotation with one plowing on 28-30 cm per rotation.

Factor B (a background of mineral feed):

1. An adding on 1 hectare of crop rotation area $N_{75}P_{60.}$
2. An adding on 1 hectare of crop rotation area $N_{97,5}P_{60.}$

A soil of the research field is dark brown medium loam with a low security of nitrates and and medium-sized mobile phosphorus and exchange potassium, the humus content in the layer of 0 - 30 cm amounted to 2.25%.

The farming equipment cultivation of winter barley of sort Worthy was recognized for the irrigated lands of southern steppe of Ukraine, in addition to the factors that were investigated.

During the growing season, the soil moisture in the layer of 0-40 cm was maintained at no lower than 70% NV.

The research program included the identification of indicators that make it possible to track changes in agro properties and water regime under the influence of different methods of basic soil cultivation and doses of mineral fertilizers and to establish crop yields and productivity of crop rotation. During the experiments, guided by the methodology of field and laboratory studies on irrigated lands [6].

The results of research. Favorable conditions for plant growth and development are generated at an optimal structure of the treated soil. Numerous studies have been proven the need to invent such parameters of looseness or density of the soil constitution, which would more fully comply with the requirements of biological crops. It is found that the soil in which the equilibrium density less than optimal for a given culture, the need for annual deep treatments eliminates [7, 8].

For most crops the optimal bulk density value is 1.1-1.3 g / cm3. [9] The rotations on irrigated lands proportion of corn and soybeans from 25 to 50.0% [10]. These crops for intensive growth and development require loosened enriched with nutrients and moisture, and the plowing of the root zone. Studies have shown that the optimal density of the addition of topsoil for soybeans is 1.10-1.20 g / cm^3. The growth of this indicator over 1.27 g / cm^3 for the period of the crop has a negative impact on the future growth and development of plants. The optimal density of the addition of the arable layer of corn is also in the range 1.10-1.30, and for winter barley 1.10-1.40 g / cm^3.

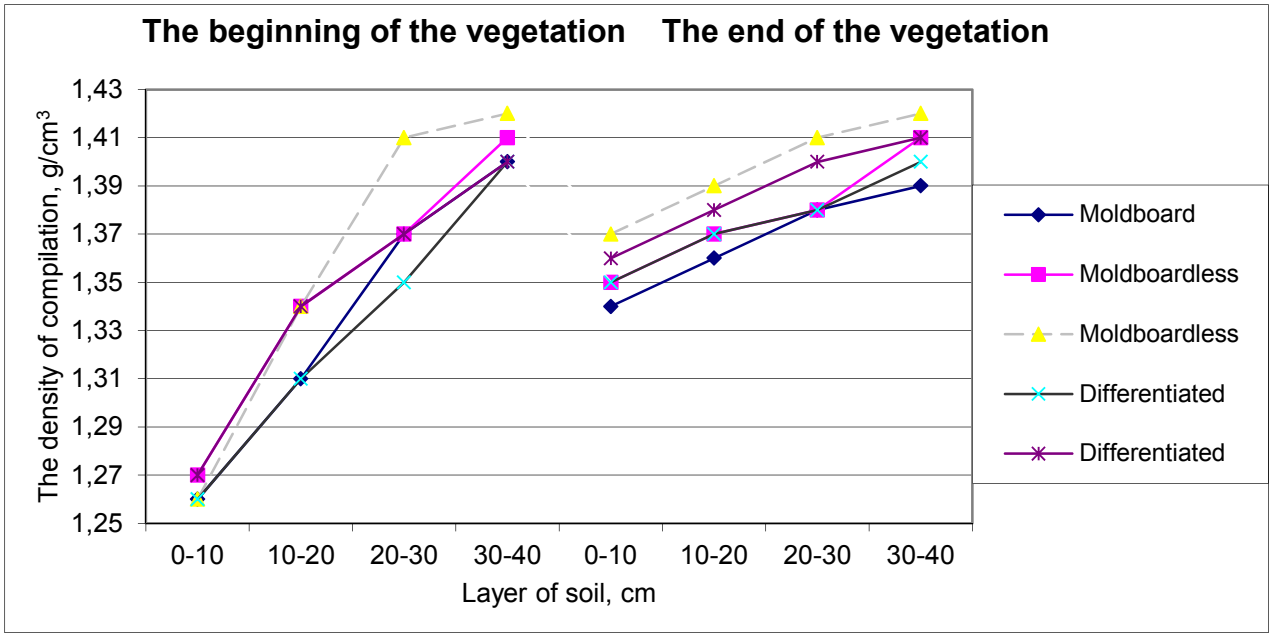
Studies of the Institute of irrigated agriculture HAAH have proved that most fully, on dark chestnut soils of the south of Ukraine, these conditions provide methods of primary tillage with rotation of slices that make organic fertilizer in the form of by-products (straw, corn stalks and soybean) and sedentary phosphate fertilizers wrapped to a depth of 20-22 to 28-30 cm, that is stable in the lawer of wetting zone and maximum distribution of the root system. Thus, during the germination of crops in variants of primary subsurface treatment, density adding topsoil of 0-40 cm was 1,34-1,36, and in variants of midwater moldboard and differentiated systems - 1.33 - 1.35 g / cm^3. This level of complex density provides favorable conditions for the growth and development of winter barley at the same time because of moldboardless ways these figures were lower than biologically justified for corn and soybeans on 4.6%. The precipitation of autumn-winter period and irrigations significantly compacted soil. At the same time preserved pattern noted in the initial period of the growing season - because of the boardless way of indicaters of densities adding were lower biologically justified for corn and soybeans on 6.9-7.7% (Table 1.).

1. The density of adding layer of dark brown soil of 0-40 cm, depending on primary processing in the rotation, g / cm3

The system of primary soil cultivation	The corn for grain	Soy	Barley	Soy	On average for crop rotation
Moldboard	1,35 1,36	1,32 1,36	1,33 1,38	1,33 1,36	1,33 1,36
Moldboardless	1,35 1,37	1,34 1,39	1,34 1,39	1,35 1,36	1,34 1,38
Moldboardless	1,36 1,39	1,36 1,40	1,35 1,42	1,36 1,38	1,36 1,40
Differentiated	1,34 1,36	1,33 1,38	1,33 1,39	1,34 1,38	1,33 1,38
Differentiated	1,34 1,36	1,34 1,39	1,35 1,41	1,35 1,39	1,34 1,39
$NCI_{05,\ g/cm3}$	0,07 0,06	0,05 0,06	0,08 0,09	0,06 0,07	

Note. The numerator - is the beginning of growing season, the denominator - is the end of growing season.

Particularly important in the initial phases of plant growth and development is the dynamics of changes in the density of the addition with the deepening from 0-10 cm to 30-40 cm. The most appeared loosened soil layer 0-20 cm in the embodiment of plowing to a depth of 20-22 to 28-30 cm in the midwater moldboard processing system, and the use of subsurface treatment as pelagic and shallow isobathic, resulted the sealing of separate with the deepening from 0 - 10 and 10-20 cm on 4,0-8,8% compared with the control (pic.1).



Pic. 1 – The dynamics of density formation of soil layer layout 0-40 cm during vegetation periods.

In this period significantly more pronounced the lower layers of soil compaction (20-40 cm) as compared with a layer of 0-20 cm, both variants of the experiment and sown crops. Maximum indicators of adding

density in the soil layer of 30-40 cm, an average of the crop rotation, corresponded to an embodiment of shallow processing on 12-14 cm in the system of isobathic subsurface soil treatment and were 1,40-1,45 g / cm3. At the same time, a significant difference in the values of the test parameter in the soil layer 0 - 40 cm between the options of experience hasn't established.

Thus, due to the fact that the upper permissible limit of the optimum packing density for cereal spikes is 1.35 g / cm^3, it is advisable for them to replace the plow and the deep unpolar loosening on the shallow disk primary tillage. On the dark chestnut medium-sand and heavy-gravel soils whose density in equilibrium reaches 1.40-1.45 g / cm3 for corn and soy, the use of soil cultivation without rotation of the chute (или chip), especially shallow and surface, should be avoided.

Thus, in determining in the the early growing season plants, a porosity of layer of the soil 0-40 cm, an average of the rotation was within 48,0-48,9%. A significant difference between the variations of the basic soil cultivation before harvesting also detected. The indicators of soil porosity, even after prolonged use of isobathic shallow subsurface tillage (variant 3) were in the optimal range for winter barley and did not meet the biological requirements to them such crops as soybeans and corn. The indicators of adding density contribute the creation of conditions for absorbing and filtering of water, providing the accumulation of moisture in the autumn and winter and the rational use of it throughout the growing season.

The higher indicators of density adding and correspondingly lower porosity due boardless processing methods, especially during prolonged use of small loosening in the rotation (option 3), led to lower permeability at the beginning of growing season of crops on на 6,9-17,2% (table 2).

2. The water permeability of the soil, depending on the basic processing in the 4-pole crop rotation, mm / min

The system of primary soil cultivation	The beginning of vegetation				On average for crop rotation
	The corn for grain	Soy	Barley	Soy	
Moldboard	3,5	3,3	2,5	2,3	2,9
Moldboardless	3,3	3,1	2,5	2,1	2,7
Moldboardless	3,0	2,6	2,2	2,0	2,4
Differentiated	3,4	3,3	2,6	2,6	3,0
Differentiated	3,4	3,0	2,6	2,4	2,8
$NCI_{05,\ mm\ /\ min.}$	0,2	0,4	0,2	0,2	

The maximum values of the rate of water harvesting and filtration correspond to the variant of multi-depth moldboard and differentiated-1 basic soil cultivation in crop rotation. Before harvesting for a prolonged use of shallow loosening in the crop rotation (option 3), as compared to control, there was a decrease in permeability as in the beginning of the vegetation of agricultural crops.

Summing up, we can conclude that under the influence of different ways and the depth of the main processing dark chestnut medium loam soil, mode of irrigation and fertilizer formed agrophysical properties (density build, porosity, water permeability), which are optimal for winter barley and partially satisfy the requirements for them by corn and soy.

During the growing season of crop rotation the layer moisture of soil is 0-100 cm in the experiment was maintained at 70% NV irrigations. Respectively in 2015 there was 5 and 1 and a half rate of 500 m^3 / ha.

The amount of water that used by crops during the growing season on transpiration and evaporation of soil, characterized by the total water consumption (table 3).

3. The total water consumption of agricultural cultures of the 4-pole rotation link, depending on the basic soil cultivation in crop rotation, m^3 / ha

The system of primary soil cultivation	The corn for grain	Soy	Barley	Soy	On average for crop rotation
Moldboard	3510	3230	2000	3160	2975
Moldboardless	3170	3260	2290	3280	3000
Moldboardless	3250	3310	2340	3390	3070
Differentiated	3200	3250	2040	3180	2920
Differentiated	2960	3230	2180	3200	2890

The total water consumption of crop with an average of the crop rotation, ranged between 2890 - 3070 m^3 / ha.

How productive plants spend moisture on the formation of a unit of yield indicates the coefficient of water consumption. The most effective moisture was used to form a unit of yield for a differentiated -1 system of cultivation, where the formation of one ton of production consumed 820 m3 of water, while for a multi-depth moldboard and chizel tillage system water flow increased to 840 and 1000 m3. The use of single-pitched shallow (12-14 cm) disk loosening during rotation of crop rotation led to an increase in water consumption for the formation of one ton of production by 47,6% (table 4).

4.The coefficient of total water consumption of crops of the 4-pole rotation link, depending on the basic soil cultivation in crop rotation, m^3 / t

The system of primary soil cultivation	The corn for grain	Soy	Barley	Soy	On average for crop rotation
Moldboard	530	1110	590	1130	840
Moldboardless	560	1420	670	1380	1000
Moldboardless	740	1740	670	1820	1240
Differentiated	480	1160	580	1050	820
Differentiated	440	1200	600	1180	850

Increasing the dose of nitrogen fertilizer to 97.5 kg / ha a.e. provided higher yields of crop rotation, at the same time pattern was observed in making a dose of 75kg / ha a.e. was preserved (table 5).

5. The productivity of agricultural crops for different systems of basic cultivation and fertilization and productivity of 4-way cultivating crop rotation for irrigation of the South of Ukraine, t / ha (average for 2011-2015)

The system of primary soil cultivation (Factor A)	Agricultural crops				Product output, g.u
	barley	soy	the corn for grain	soy	
An adding on 1 hectare of crop rotation area $N_{75}P_{60}$ (Factor B)					
Moldboard	3,83	3,09	11,79	3,24	6,64
Moldboardless	3,68	2,99	11,47	3,03	6,39
Moldboardless	3,41	2,23	9,50	2.32	5,18

Differentiated	3,67	3,02	11,98	3,06	6,55
Differentiated	3,46	2,62	11,96	2,62	6,12
$NCl_{05,\ t/ha}$	0,22	0,25	0,59	0,20	
An adding on 1 hectare of crop rotation area $N_{97,5}P_{60}$ (Factor B)					
Moldboard	4,29	3,43	14.32	3,46	7,65
Moldboardless	4,21	3,32	13,93	3,21	7,35
Moldboardless	3,82	2,51	11,58	2,54	6,01
Differentiated	4,15	3,40	14,72	3,31	7,62
Differentiated	4,07	2,93	14,27	2,88	7,05
$NCl_{05,\ t/ha}$	0,28	0,24	0,74	0,23	

The use of fertilizers for all by-products of agricultural crops and increasing the dose of nitrogen fertilizers from 75,0 to 97,5 kg / ha a.e. per hectare of crop rotation area with seed inoculation with soy ryzogumin contributed to the growth of crop rotation productivity by 15.0-16.3% of grain units in accordance with the basic cultivation systems.

Conclusions

The use of differentiated primary tillage systems and crop by-products making crop rotation and fertilizer dose $N_{97,5}P_{60}$ inoculation of soybean seeds creates favorable conditions for the formation of optimal parameters agrophysical state water regime of dark chestnut medium loamy soil providing rotation performance at 7.62 t / ha of grain units.

Due to the cost saving on basic cultivation and technology of growing crops in general, the level of profitability of the production of differentiated-1 cultivating systems against the background of mineral fertilizer application at the dose of $N_{97,5}P_{60}$ per hectare of crop rotation area with seed treatment with soy ryzogumin was higher and was 109.8 against 107.5% for multicultural plowing.

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