OPTIMIZATION OF PHYSICAL PROPERTIES OF GROUND IN FIELD CROP ROTATIONS OF VARIOUS SPECIALIZATION

Turusov V.I., Abanina O.A.

GNU Voronezh scientific research Institute of agriculture of Russian agricultural Academy, Voronezh, e-mail: niish1c@mail.ru

Intensification of agricultural production, introduction and active usage of ground cover of black earth soils, irrational usage of different techniques of soil treatment is accompanied with destruction of structure, formation of a bigger part of blocky and largely-blocky fractions and dust, degradation in water-physical characteristics. Eventually, all that has a negative effect on growth and development of cultural plants, their productive ability decreases. And though generally sharp alterations in physical conditions of black earth are registered only during the first years after ploughing up (Y.I. Cheverdin, 2009), a quasi-balanced condition is established and temps of the soil structure destruction slows gradually (O.A. Chesnyak, G.Y. Chesnyak, 1968). In terms of significant increase in anthropogenic strain over agrocenosis, structural-aggregate composition of black earth suffers significant qualitative and quantitative alterations.

The research was completed within long-term stationary tests of the laboratory of ecological-landscape crop rotations of GNU Voronezh НИИСХ Россельхозакадемии in 2008–2010. Common mid-heavy hard-loamy black earth served as the soil of the tested area. Humus content in the layer of 0–40 cm equaled 6,5%, general nitrogen – 0,29%, general phosphorus – 0,21%, general potassium – 1,8%, easy-hydrolized nitrogen – 63,2 mg/kg, the sum of the absorbed bases – 68,6 mmole(equal)/100 g of soil, pHkcl – 7,1. The test field was located on a territory with a slight inclination up to 10 of north-west exposition.

Fiends if crop rotations with different duration of esparcet usage served as research objects. Crop rotations were the following: **rotation 1** – black fallow – winter wheat – sunflower – barley – pea – winter wheat – corn – barley – buckwheat – spring wheat (control), **rotation 2** – black fallow – winter wheat – barley + esparcet – esparcet – winter wheat – sunflower, **rotation 3** – black fallow – winter wheat – barley + esparcet – esparcet – esparcet – winter wheat – sunflower, **rotation 4** – pea – winter wheat – sunflower – barley + esparcet – esparcet – winter wheat – barley, **rotation 5** – pea – winter wheat – barley + esparcet – esparcet – esparcet – winter wheat – spring wheat – barley.

Studying alterations in physical characteristics of soils under impact of esparcet of different use period in field crop rotations with different saturation of crops was among the objectives of our research.

Research results. Structural content of the studied soils in different variants of crop rotaions is non-homogenous. It is linked, first of all, with different level and intensity of anthropogenic strain, and also environment-regulation role of each specific produced crop. In our case bean component had a significant influence upon the structural composition. It served as soil structure enhancer. And long-year bean culture – esparcet played a special part in the studied crop rotations.

The completed research of structural-aggregate condition in different kinds of crop rotations allow us to state some definite legislations. Qualitative indexes of the structure can be generally characterized as non-typical for the black earth according to all its parameters. However, analysis of the received data shows a general degradation of indexes of structural-aggregate condition under one-year crops. These alterations were conditioned by a high content of blocky aggregates. Under barley contents of blocks (fractions of more than 10 mm) altered in ploughing layer of soil in general from 8,4 to 19,0% depending on type of crop rotation. In under-ploughing horizon the part of blocky aggregates was higher and equaled 15,5–35,7%. In grain-fallow-ploughing rotation where ploughing crop served as a precedent of barley higher content of blocky fractions was typical. The part of puverescent fraction in all crop rotations was practically the same and did not depend on the type of rotation. It altered within 1,7–6,2% with higher values in root-inhabited layer.

Changes in correlation of cultures in structure of crop rotations reflected in alterations of part of each fraction in forming agronomically-valuable soil peds. Grain aggregate of size from 1 to 5 mm are a dominating fraction. Regardless the fact that the major part in contents of structural separates of size from 1 to 5 mm, differences in variants were insignificant. In the higher soil horizon in grain-fallow-ploughing rotation under barley that served as a precedent for beans, part of these fractions was so small the smallest and equaled 55,2% in average during the years of research. Bean grass had a positive impact over physical characteristics, especially in links of rotation without clean fallow. In grain rotations the part of soil peds with size of 1–5 mm increased up to 61,4–62,5%.

Mezoaggregates with soil fractions of size 5–10 mm were in a submissive condition and their quantity oscillated within 11,3–15,8% and it practically didn't depend on the type of rotation, excluding the grain rotation with one field of esparcet. The lowest content of this fraction was registered here (7,3%).

The most noticeable alterations were registered for the blocky (> 10 mm) part of the structure. In grain rotations with 1 and 2 fields of esparcet a decrease in lump fraction by 1,1–2,2 was registered. Part of the puverescent fraction for all types of rotation was relatively the same.

Alteration and regulation of structural content in soil profile during an intense agricultural production is one of the most important and hard-regulated factors that define dynamics of a soil productivity. This inducator is relatively stable. However, many researches point out int alteration under impact of agric-technical methods. In crop rotations usage of bean long-year grass has led to an improvement in soil structure. It was conditioned by processes of coagulation of soil fractions. Therefore, data on the impact of bean component over redistribution and correlation of aggregates carries the most significant practical interest. Under one-year bean crop (pea), like under esparcet of the first year of use, the maximum part in structure of separate soil peds belonged to aggregates of size 1–5 mm.

During the branching period (growing of vegetative mass) of esparcet, mezoaggregates have become the most sensitive against impacts of the produced crops. Under one-year crop of esparcet contents of fractions of size 1–5 mm equaled 55,7–59,3 %. Under two-year period of usage their part decreased down to 47,0–49,5 %. At the same time, an increase in soil fractions of 5–10 mm from 10,5–16,9 to 19,5–22,3 %. Besides, an expected decrease in lump aggregates in grain-grass crop rotations took place. On contents of puverescent fraction no significant changes were registered.

Introduction of long-years bean grass into a structure of crop rotations leads to a decrease in size growth of an average-weighted size of dry aggregates (Dc), in other words, blockyness, while preserving a very low average-weighted diameter of aggregates after watering (Dm) (table). At the same time entropy of distribution of dry aggregates (Hc) and watered aggregates under esparcet increases on the following crop. Combined with changes in Dc and Dm it means that redistribution in qualitative content of structural separates, decrease in part of puverescent and grain fractions, and increase in mezofractions takes place in dry condition.

Average-weighted diameter (Dc) of soil fraction, dry sorting, 2008–2010

Crop rotation	Soil horizon	Barley, maturity	Esparcet, growth of vegetative mass	Esparcet, ploughing-up	Pea, full maturity	Winter wheat, discharge into pipe
Grain-fallow-ploughing	0–10	4,14	–	–	3,32	3,08
	10–20	4,12	–	–	4,51	3,66
	20–30	5,17	–	–	4,78	4,54
	30–40	5,07	–	–	5,17	5,77
	0–40	**4,62**	–	–	**4,44**	**4,26**
Many-field grass with one field of esparcet	0–10	4,05	3,21	3,16	–	4,45
	10–20	4,60	5,03	4,76	–	4,62
	20–30	4,74	5,13	4,55	–	5,37
	30–40	5,57	4,35	5,03	–	5,23
	0–40	**4,74**	**4,43**	**4,37**	–	**4,91**
Many-field grass with 2 fields of esparcet	0–10	4,39	4,22	3,92	–	4,13
	10–20	4,82	5,21	5,00	–	4,26
	20–30	4,89	4,74	5,52	–	4,56
	30–40	5,44	5,26	5,53	–	4,62
	0–40	**4,89**	**4,86**	**4,99**	–	**4,39**
Grain with one field of esparcet	0–10	3,35	3,93	3,52	–	3,82
	10–20	4,32	4,67	4,29	–	4,45
	20–30	5,33	4,81	4,67	–	5,96
	30–40	6,22	4,62	4,29	–	5,48
	0–40	**4,80**	**4,51**	**4,19**	–	**4,93**
Grain with two fields of esparcet	0–10	3,52	4,20	4,19	–	4,62
	10–20	4,96	4,78	4,97	–	5,30
	20–30	6,08	4,62	5,10	–	4,69
	30–40	5,73	4,23	4,93	–	4,98
	0–40	**5,07**	**4,46**	**4,80**	–	**4,90**

With similarities in general trends, crop rotations with many-year grass have a higher stability and ecological flexibility against an intense anthropogenic impact in comparison with grain-fallow-ploughing crop rotations. It is reflected by the fact that bean component provides not only for stabilization of humus condition, but more by an optimization of ploughing layer of the black earth.

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