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HUMUS CONTENT IN BLACK SOILS IN RELATION WITH CROP ROTATIONS AND FERTILIZING PRACTICES

The research has shown the influence of sugar beet fertilizing practices on humus content in long-term fertilizing. The usage of 25 t/ha of manure + straw + $N_{90}P_{120}K_{90}$ for sugar beet and 6.25 t/ha of manure + $N_{33,8}P_{45}K_{33,8}$ per a crops rotation provides an increase in humus content in tilled lands as well as in sub-tilled soil layers.

***Keywords**: typical weak-salt chernozem; humus content; rotation links; fertilizing practice; straw*

Introduction. It is known that the productivity of chernozem depends largely on fertilizing practice, rotation links, saturation of row crops and grain crops in plots, and the presence of perennial grasses in the plots. These are the main factors that have a positive influence on the content of organic matter in soil of field crops rotation [1-5].

According to G. Chesnokov [1, 2] the balance of organic matter in crops rotations depends on the crops and the plots. In particular, according to him the loss of humus in black fallow could reach 1.2 - 1.6 t/ha, in the raw crop fields the loss could reached 7.15 t/ha, in winter wheat fields of 0.4 - 0.7 t/ha, and in spring grain fields of 0.5-0.6 t/ha.

Quantity and texture of humus also significantly influence on the intensity of humus mineralization. According to L. Barshtain [3], in leached poor humus chernozem of Nosivsky Department of Chernihiv EBS (humus content less than 3%) in crops rotations with 30% of raw crops, 40% of grain crops, 30% of legumes, including a section with perennial grasses, the loss of humus in 14 years was only 0.02% of absolute or about 1% of the total initial quantity.

The quantity of humus in black regradated soils with usage of 10 t/ha manure + $N_{62}P_{62}K_{62}$ per 1 ha of tilled land for 32 years decreased by 0.2%. At the same time, usage of manure in higher quantity (15 tons per 1 ha of tilled land) in combination with $N_{63}P_{63}K_{63}$ created conditions for reproduction of humus reserves in soil, and, as a result, its content increased from 3.03% to 3.10% [4].

In the research of A. Martynovych and P. Martynovych [5] carried out on ashed chernozem in corn-beet crops rotation in Verhniatska EBS mineral fertilizers increased the organic matter content by 0.21% for 50 years in average, while with using of organic-mineral fertilizing practice (7.7 t/ha of manure + $N_{60}P_{60}K_{60}$) mineral fertilizers increased the organic matter content by 0,44%.

At the same time, scientific literature contains available data, which affirm that the usage of mineral fertilizers in sufficient moisture area in chernozem accelerates mineralization of humus significantly. Moreover, the intensity of this process depends on the rate of mineral fertilizers usage and on presence of legumes in crops rotation [6].

Alongside with the usage of manure and mineral, plough of after-harvest residues of all crops rotation also supports increasing of humus content in soil and carbon recycling in agricultural practice [7].

The aim of the research was to find out the effect of crops rotation in plots on humus content depending on usage of fertilizers and after-harvest residues as an alternative source for organic fertilizers.

Materials and methods. The investigation was carried out in Veselopodilska EBS IBCSB NAAS (Semeniv district of Poltava region) in long-term stationary experiment in short crops rotation during 1978-2012.

Soils of the experiment field were typical poor-salt chernozem with the following agrochemical characteristics of tilled soil: pH of 7.2-7.5, humus content (by Turin) of 4.5-4.7%, alkali-hydrolyzed nitrogen of 180 mg/kg of soil, mobile phosphorus and potassium (by Machygin) of 19-20 mg/kg and 100-110 mg/kg, respectively.

Crops rotations were as follows:

- Grain row crops rotation *I (proportion of row crops of 50%, grain crops of 50%)*: 1) silage maize; 2) winter wheat; 3) sugar beet; 4) barley;
- Grain row crops rotation II *(proportion of row crops of 25%, grain crops of 75%)*: 1) pea; 2) winter wheat; 3) winter wheat; 4) sugar beet;
- Grain row crops rotation *(proportion of row crops of 25%, grain crops of 50%, black fallow of 25%)*: 1) black fallow; 2) winter wheat; 3) sugar beet; 4) barley.

Fertilizing practice in crops rotation is shown in the Table 1. The straw of winter wheat was ploughed into the soil together with manure and chemical fertilizers.

The total humus content was determined by the method of V. Turin [8] at the end of the vegetation season of sugar beet in the first field of crops rotation comparing with the beginning of the crops rotation.

Results of the research. The experiments performed in short-term crops rotation showed that humus content largely depends on fertilizing practice and crops rotation in plots. Thus, the soil layer in row crops rotation in the plot with silage maize with the option without fertilization the humus content in tilled land decreased to 4.00%, which was less by 0.28% compared to the beginning of the crops rotation. The amount of humus in the ploughed layer in raw crops rotation, where sugar beets were sowed in two fields of grain crops (winter wheat over winter wheat), was 4.10%, whereas the amount of humus in the ploughed layer at the beginning of the crops rotation was 4.30%.

Loss of humus reached 0.20%, which was less by 0.10% comparing with raw crops rotation, where the proportion of row crops was 50%. The significant decrease of humus (by 0.40%) was observed in row crops rotation in the plot with black fallow. In this case, comparing with the raw crops rotation, loss of humus was more by 0.20% that is caused by enhanced mineralization of humus under black fallow. The annual losses of humus in the ploughed layer short-term crops rotation were 0.30, 0.20 and 0.40 t/ha respectively. It means that the decrease in proportion of row crops and black fallow in crops rotation reduce losses of humus in soil due to its dehumification.

Regarding the content of humus in sub-tilled soil layer the situation was similar to the ploughed layer. Thus, loss of humus in crops rotation in the plot with silage maize reached 0.20%, while in case of crops rotation saturation with 75% grain loss of humus decreased to 0.15%.

Within the usage of 25 t/ha manure + $N_{90}P_{120}K_{90}$ for sugar beet and 6.25 t/ha manure + $N_{33,8}P_{45}K_{33,8}$ for crops rotation humus content increased in row crops rotation in the plot with maize silage by 0.21%, in two fields with winter wheat it increased by 0.20%. In the grain-fallow-raw crops rotation, where sugar beets were sowed in the plot with black fallow, increase of humus content comparing to the start of the crops rotation was 0.10%, which constituted 4.47% respectively. Under the influence of this fertilizing practice increase of humus content in sub-tilled soil layer of all short-term row crops rotations was by 0.06% and 0.10%, while in grain-fallow-raw crops rotation it was by 0.14%.

An important source of stabilization in humus with contemporary methods of economy is the usage of by-products of the crops as an alternative source of manure. Its efficiency depends on kind of soil, climatic conditions, and fertilizing practice in crops rotation, because these factors have significant influence on the intensity of mineralization and synthesis of humus.

According to the experiment stabilization of humus content in all short-term crops rotations was observed in all options, where fertilizing practice was combined with the usage of straw, manure and mineral fertilizers for sugar beet.

Table 1

Influence of sugar beet fertilizing practice on humus content in short-term crops rotations VEBS, %

No	Subject of options	Soil layer	1978	2012
Grain row crops rotation: 50 % of row crops, 50 % of grain crops				
27	Without fertilizers	0-30	4.28	4.00
		30-50	3.00	2.70
28	25 t/ha of manure + $N_{90}P_{120}K_{90}$	0-30	4.30	4.51
		30-50	3.84	3.90
29	25 t/ha of manure + straw + $N_{90}P_{120}K_{90}$	0-30	4.30	4.65
		30-50	3.70	3.88
Grain row crops rotation: 25% of row crops, 50 % of grain crops, incl. 25 % of pea				
63	Without fertilizers	0-30	4.30	4.10
		30-50	3.60	3.45
64	25 t/ha of manure + $N_{90}P_{120}K_{90}$	0-30	4.30	4.50
		30-50	3.60	3.80
65	25 t/ha of manure + straw + $N_{90}P_{120}K_{90}$	0-30	4.40	4.69
		30-50	3.80	3.90
Grain row crops rotation: 25 % of black fallow, 25 % of sugar beet, 50 % of grain crops				
45	Without fertilizers	0-30	4.32	4.00
		30-50	3.50	3.30
46	25 t/ha of manure + $N_{90}P_{120}K_{90}$	0-30	4.37	4.47
		30-50	3.31	3.45
47	25 t/ha of manure + straw + $N_{90}P_{120}K_{90}$	0-30	4.47	4.60
		30-50	3.45	3.60

Under the results of the experiment humus content in the ploughed layer in grain raw crops rotation increased by 0.25% and 0.29%, in grain-fallow-raw crops rotation it increased by 0.13% (in absolute figures it was 4.65% and 4.84%, and 4.60% respectively). The increase of humus content was observed in the sub-tilled soil layer. This is due to the fact that the straw has more solids content and helps to enrich the balance of humus in the soil as well as more full recycle of carbon in agricultural ecological system.

Conclusions.

1. Increase of row crops proportion at 50%, and black fallow - at 25% without usage of fertilizers leads to an annual loss of humus from 0.20 t/ha to 0.40 t/ha.

2. With using of 25 t/ha of manure + $N_{90}P_{120}K_{90}$ for sugar beet and 6.25 t/ha of manure + $N_{33,8}P_{45}K_{33,8}$ for a crops rotation the increase in humus content was observed that happened due to influence of fertilizers as well as increasing of insoluble residue proportion.

3. Ploughing down straw combining with 25 t/ha of manure + $N_{90}P_{120}K_{90}$ contributed increasing in humus content by 0.29% in the grain row crops rotation with a share of 25% of row crops.

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Аннотация

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Содержание гумуса в черноземных почвах в зависимости от севооборота и системы удобрения

Показано влияние системы удобрения сахарной свеклы на содержание гумуса при длительном применении удобрений. Установлено, что при использовании 25 т/га навоза + солома + $N_{90}P_{120}K_{90}$ под сахарную свеклу и 6,2 т/га навоза + $N_{33,8}P_{45}K_{33,8}$ за ротацию севооборота, наблюдается повышение содержания гумуса как в пахотном, так и подпахотном слое почвы.

Ключевые слова: *черноземы типичные слабосолонцеватые, пахотный слой, содержание гумуса, звенья севооборота, система удобрения, солома*

Annotation

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Organic matter content in black soils as depending on crops rotations and system of fertilizers

Shown is the impact of fertilizing systems on the content of organic matter under long-term fertilizers application in sugar beet. When applying 25 t/ha manure + straw + $N_{90}P_{120}K_{90}$ and 6,25 t/ha manure + $N_{33,8}P_{45}K_{33,8}$ in average for crops rotation the increase of organic matter content both in topsoil and subsurface layer is observed.

Keywords: *weakly solonetsous black soil, organic matter content, crops rotation chains, system of fertilizers, straw*