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CONTENT OF LABILE HUMUS SUBSTANCES IN TYPICAL CHERNOZEM OF RIGHT-BANK FOREST-STEPPE ZONE OF UKRAINE AS EFFECTED BY PLANT RESIDUE INPUTS IN SHOT-TERM CROP ROTATION

Different variants of soil fertilizing in a shot-term crop rotation influenced the amount of crop residues, soil organic matter balance, and labile SOM content in the soil. Straw must be applied in rates no less than 5.0 t/ha, fresh organic residues increase total SOM concentration in the soil but the percent of labile hummus substance remains practically independent on fertilizing scheme.

Key words: *typical chernozem, straw, plant residues, SOM balance, green manure, SOM content, labile humus substances*

Introduction. Soil fertility and supply of the essential nutrient elements during the periods of crop growth and development as well as an overall formation of high crop grows yields are connected with the amount of soil organic matter (SOM) in the soil [1]. It has been establishment that the small grain crop yields show correlation with labile SOM content in the soil and the inputs of brash organic residues. Intensified crop production has as one of its aims not to allow the SOM losses above a certain limit as the losses of labile SOM.

Crop residues left on the surface and in the soil make the most sizable source of SOM accumulation in present-day crop production systems. In typical crop rotations, still employed in Ukraine, plant residues make a more important SOM source than organic maters. SOM accumulation in the soil occurs even during the vegetation of crops owing to root regeneration, root exudates, and intensive microbial activity. Thus agricultural crops, as well as other plants, are not only the "consumers", but active "creators", or producers of soil fertility [2].

Plant residue accumulation in the soil is conditioned by plant species, placement in crop rotations, and ratios among various crop in a given crop rotation. Changing the ratios among the areas of different crops, it is, to a definite extent, possible to increase the amount of fresh plant material entering the soil.

Plant residues contain numerous elements of nutrition which can be utilized by the future crops [3]. According to different authors [4,5], with crop residues the soil receives, in % of their total amount in the yields, 27-60.5 % N, 18.5-51.7% P_2O_5, 16.7-48.1% K_2O, and 27.6-54% Ca.

The stability of soil fertility parameters depends on the dynamic equilibrium between the processes of humification and those of residue and SOM decomposition (mineralization). Virgin soil formation is characterized by the dominance of humification, so that total SOM content in the soil gradually increases until it reaches an equilibrium. Soil tillage and other crop production practices intensity SOM mineralization. Total SOM content decreases till it reaches another equilibrium [6].Thus in order to ensure a non-deficit SOM balance in cultivated soils, it is necessary to find new ways to increase fresh SOM inputs, so that humification would dominate over mineralization.

The purpose of Research was to study the influence of different variants of fertilizing on crop yields, amounts of plant residues, and labile SOM content in the soil.

Materials and methods. Research activities were carried out in Right-Bank Forest-Steppe zone of Ukraine, on typical light loam chernozem a dominant soil mapping unit. In soil was light loam by texture and belonged to Fastiv agro-soil region. Crop rotation consisted of four crops: soybean – winter wheat – corn (maize) for grain – barley. Fertilizing variants (per hectare of a crop rotation) are as follows: 1) control (no fertilizers), 2) 1,2 $t \cdot ha^{-1}$ straw + N_{12} + $N_{78}P_{68}K_{68}$; 3) 1,2 $t \cdot ha^{-1}$

straw + N_{12}+ green manure + $N_{78}P_{68}K_{68}$. Soil tillage system was as that adopted (recommended) determined by Tiurin procedure in Simacov modification, and labile SOM substances were extracted using 0.1N NaOH extract.

Results and discussion. The highest crop yields were obtained on test variants with the application of straw (1.2 t/ha), use of green manure crops, and mineral fertilizing with $N_{78}P_{68}K_{68}$ (Table 1).Soybean yield has been 3.4 t/ha which is 1.9t/ha more than on control variant. Winter when also positively reacted on fertilizer application. On control variant the yield of grain was of 2.73 t/ha, whereas straw and fertilizing increased it by 1.64 t/ha; green manure further increased crop yield by 0.19 t/ha. Corn for grain also showed increases of crop yields under the influence of fertilizing as compared with controls (by 2.4-3.1 t/ha). Combined application of organic manures and mineral fertilizers ensured the yields of barley within 3.79-4.0 t/ha.

While computing SOM balance, the following income sow ices were taken into account: organic manures, plowed –in residues of crops, additional application of non-produce residues, and green manure crops. SOM losses were considered to be caused by mineralization and soil erosion. Since 2003, SOM balance is calculated not taking into account of green manure crops [7].

The amounts of crop residues increase with increasing crop yields. The greatest amount of them comes into the soil and on its surface after winter wheat (12.1-12.2 t/ha), as straw and chaff are used as organic manure. That is why the amount of SOM which may be formed from wheat residue is the greatest, compared with the other crops, even when the SOM mineralization is taken into account.

Table 1

The amount of newly formed SOM in dependence on crop yield and crop residue

Crop	Parameters	Fertilizing variants		
		control (no fertilizers)	1,2 t/ha straw + N_{12} + $N_{78}P_{68}K_{68}$	1,2 t/ha straw + N_{12}+ green manure + $N_{78}P_{68}K_{68}$
Soybean	Yield, t/ha LSD_{05}=0.13	1.5	3.3	3.4
	Crop residue, t/ha	2.1	2.8	2.9
	New formed SOM minus mineralized SOM, t/ha	-1.03	-0.83	-0.82
Winter wheat	Yield, t/ha LSD_{05}=0.19	2.73	4.37	4.56
	Crop residue, t/ha	5.6	12.1	12.2
	New formed SOM minus mineralized SOM, t/ha	-0.24	1.06	1.1
Corn for grain	Yield, t/ha LSD_{05}=0.45	5.5	7.9	8.6
	Crop residue, t/ha	7.2	9.7	10.3
	New formed SOM minus mineralized SOM, t/ha	-0.13	0.4	0.5
Spring barley	Yield, t/ha LSD_{05}=0.16	2.61	3.79	4.0
	Crop residue, t/ha	4.2	5.2	5.3
	New formed SOM minus mineralized SOM, t/ha	-0.3	-0.09	-0.06

The least amount of crop residue (2.1-2.9 t/ha) and, consequently, the least amount of the SOM formed were observed under soybean with the production of which the SOM balance has been negative on both non-fertilized test variants. Under spring barley, the amount of crop residue left in the soil or on its surface is relatively low (4.2-5.3 t/ha). Mineralization processes dominate

over those of soil hummus formation, go the SOM balance also remains negative, but less so than on soybean fields.

Corn has a greater biomass and longer crop growth period than the previous two crops, and on the variants with straw after action and green manure crop the amount of SOM formed may reach 0.4-0.5 t/ha.

Application of straw and green manure, combined with mineral fertilizing creates positive SOM balance (0.54-0.72 t/ha), but on control variants the balance remains negative (-1.7 t/ha) as shown in Table 2. According to these calculation total SOM content wile, with time, be more than two times different between control and fertilized variants.

Table 2

SOM balance and labile hummus substance content depending on fertilizing

Fertilizing variants	Soil depth, cm	Soil organic matter balance during the time of crop rotation, t/ha	Labile hummus substance content, %	Total SOM content, %
Control (no fertilizers)	0-10	-1.7	0.36	3.6
	10-20		0.34	3.55
	20-30		0.26	2.80
	30-40		0.19	2.58
1.2 t/ha straw + N_{12} + $N_{78}P_{68}K_{68}$	0-10	0.54	0.38	3.95
	10-20		0.37	3.80
	20-30		0.28	2.98
	30-40		0.19	2.79
1.2 t/ha straw + N_{12}+ green manure + $N_{78}P_{68}K_{68}$	0-10	0.72	0.41	4.20
	10-20		0.39	3.80
	20-30		0.29	3.18
	30-40		0.2	2.78

Hummus substance extracted by 0.1N NaOH are the most labile portion of SOM. They make the nearest reserve of plant nutrition and may be completely mineralized to the end of crop vegetation period. Their amount, there fore characterizes soil fertility and direction of soil formation.

The amount of labile SOM was within 0.34-0.41% in 0-10 and 10-20 cm of soil depth, decreasing to 0.19-0.2% in the deeper layers. Application of straw and the use of green manure were more effective in SOM increase then the other practices. The application of straw plus mineral fertilizing did not cause statistically significant SOM increases compared with control variants. In 0-20 cm soil layer, the fertilizers without green manure increased it by 0.35-0.6%. The increases diminish with depth, but the tendency remains.

Conclusions. To ensure positive SOM balance in a crop rotation, the residues of crop are not enough. Straw must be applied in rates no less than 5.0 t/ha. Fresh organic residues increase total SOM concentration in the soil but the percent of labile hummus substance remains practically independent on fertilizing scheme.

References

1. Жемела Г.П. Добрива, урожай і якість зерна / Г.П. Жемела – К. : Урожай, 1991. – 136 с.

2. Левин Ф.И. Количество растительних остатков в почвах полевых культур и его определение по урожаю основной продукции / Ф.И. Левин // Агрохимия. – 1977. – № 8. – С. 36-43.

3. Алиева Е.И. Накопление и разложение растительных остатков полевых культур и влияние их на баланс органического вещества и питательных элементов дерново-подзолистой почвы / Е.И. Алиева // Агрохимия. – 1978. – № 4. – С. 57-63.

4. Розкошанский А.Д. Пожнивно-корневые остатки и их роль в изменении условий почвенного плодородия / А.Д. Розкошанский // Агрохимия. – 1976. – № 1. – С. 95-100.

5. Семенов В.М. Агроэкологические функции растительных остатков в почве / В.М. Семенов, А.К. Ходжаева // Агрохимия. – 2006. – № 7. – С. 63-81.

6. Шукайло С.П. Баланс гумусу в ґрунтах Херсонської області / С.П. Шукайло //Агроекологічний журнал. – 2010. – № 3. – С. 39-40.

7. Якість ґрунту. Методи визначення органічної речовини: ДСТУ 4289 : 2004. – [Чинний від 2004-05-30]. – К.: Держспоживстандарт України, 2005. – 16 с. – (Національний стандарт України).

8. Орлов Д.С. Практикум по химии гумуса / Д.С. Орлов, Л.А. Гришина. – М.: МГУ, 1981. – 272 с.

9. Грунтознавство: Лабораторний практикум / [О.Ф. Гнатенко, Л.Р. Петренко, М.В. Капштик та ін.]. – К.: РВЦ НАУ, 2000. – 170 с.

10. Ґрунтознавство з основами геології: метод. вказівки до вивчення розділу «Балансові розрахунки в агроценозах» / [уклад.: О.Ф. Гнатенко, Л.Р. Петренко, С.В. Вітвіцький та ін.]. – К. : Вид. НАУ, 1999. – 72 с.

Анотація

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Вплив надходження рослинних решток культур короткоротаційної сівозміни на вміст рухомих гумусових речовин в чорноземі типовому легкосуглинковому Правобережного Лісостепу

Досліджено вплив різних варіантів удобрення ґрунту в короткоротаційних сівозмінах на кількість рослинних решток культур, баланс гумусу та вміст рухомих гумусових речовин у ґрунті. Встановлено, що для бездифіцитного балансу гумусу необхідним є внесення соломи у нормі 5 т/га. Зі збільшенням надходження свіжої органічної речовини до ґрунту загальний уміст гумусу зростає, а лабільна його частина залишається майже однаковою на всіх варіантах удобрення.

Ключові слова: *чорнозем типовий, солома, рослинні рештки, баланс гумусу, сидерати, вміст гумусу, рухомі гумусові речовини*

Аннотация

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Влияние поступления растительных остатков культур короткоротационного севооборота на содержание подвижных гумусовых веществ в черноземе типичном легкосуглинистом правобережной Лесостепи

Исследовано влияние различных вариантов удобрения почвы в короткоротационных севооборотах на количество растительных остатков культур, баланс гумуса и содержание подвижных гумусовых веществ в почве. Установлено, что для бездефицитного баланса гумуса необходимо внесение соломы в норме 5 т/га. С увеличением поступления свежего органического вещества в почву общее содержание гумуса растет, а лабильная его часть остается почти одинаковой на всех вариантах удобрения.

Ключевые слова: *чернозем типичный, солома, растительные остатки, баланс гумуса, сидераты, содержание гумуса, подвижные гумусовые вещества*