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CHANGES IN ORGANIC PART OF THE SOIL AND ACID-BASE BALANCE DEPENDING ON GREEN MANURE FERTILIZATION IN PODZOLIZED CHERNOZEM

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Aim. To study the changes in the content and stock of organic substances as well as the reaction of the soil environment depending on the impact of different types of fertilization of green-manured fallows. **Methods**. Field studies were conducted on podzolized heavy loamy chernozem, on loess, in conditions of Right-Bank Forest-Steppe of Ukraine. Experimental design included: sweet clover with the seeding rate of 20 kg/ha, white mustard – 20, oilseed radish – 20, spring vetch – 150, and buckwheat – 150 kg/ha with the following fertilization variants: no fertilizers – control; N_{40}; $P_{40}K_{40}$; $N_{40}K_{40}$; $N_{40}P_{40}$; $N_{40}P_{40}K_{40}$; $N_{80}P_{40}K_{40}$. The content of total carbon and nitrogen were defined using Anstett's method, modified by Ponomariova and Nikolaeva; the content of total humus in the soil prior to sowing winter wheat (the impact of green manure for a year) – according to DSTU 4289:2004, pH of the water extract – according to DSTU ISO 10390:2007. **Results.** Nitrogen-carbon ratio was in the range from 11.1 to 11.8 in the biomass of leguminous crops and from 18.8 to 20.7 – in root remains, and its highest value was observed in root remains of *Brassicaceae* crops – from 28.8 to 34.5 depending on doses and types of mineral fertilizers. Compared to bare fallow, green manure fertilization promotes humus preservation in the soil. The decrease in the level of humus intension of the soil by 0.01–0.04 % was registered both in the surface and subsurface layers in conditions of bare fallow compared to green-manured fallow. 1.67 t/ha of humus is mineralized in the soil of bare fallow. The transformation of green manure biomass allows accumulating 1.15–2.05 t/ha of humus depending on doses and types of mineral fertilizers. When the *Cruciferae* family (white mustard and oilseed radish) are used as green manure, the isohumus index is 1.52–1.55, 1.67–1.69 – for the *Leguminosae* (annual sweet clover and spring vetch), and 1.52–1.60 – for buckwheat, depending on fertilization. The humification coefficient for vegetative biomass of oilseed radish is 0.023, for spring vetch – 0.027, for buckwheat – 0.033, for white mustard – 0.035, and for annual sweet clover – 0.036. The administration of different doses and types of mineral fertilizers conditions the decrease in the coefficient of green manure fertilization. **Conclusions**. The application of green manure both with and without fertilizers compared to bare fallow promotes the preservation of humus content in the soil. The transfer of calcium from lower layers to the arable soil layer, performed by the plant root system in green-manured fallow, decreases active acidity of the soil.

Keywords: green manure crops, humus, C:N, isohumus index, acidity.

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INTRODUCTION

Chernozem fertility had been considered inexhaustible for a long time, until the necessity to restore it and to enhance its yielding capacity via the administration of both mineral and organic fertilizers was proven [1].

Periodic introduction of organic substances allow optimizing the humus condition of the soil that is in close correlation with its physical and chemical properties [2]. The main source of the input of organic substances into the soil is manure. However, even a great number of livestock at a farm may not be sufficient for systematic introduction of the optimal norm for the whole area of agricultural land. Thus, the enhancement of soil and the production of ecologically safe products of plant cultivation require the transition to biologized crop rotation, rich in leguminous crops, perennial grasses and plants, the green mass of which is used as green manure.

Annual input of free biomass in the norm of 40 t/ha, calculated per dry substance, in the 0–30 cm soil layer ensures almost as high level of humus content as that for wild land [3].

Table 1. The C:N ratio in the green manure biomass depending on fertilization (2013–2015)

Experiment variant		Biomass	Root remains
Fertilizers	A green manure crop		
No fertilizers (control)	Sweet clover	11.5	20.3
	White mustard	19.8	33.4
	Oilseed radish	19.7	33.6
	Spring vetch	11.7	20.7
	Buckwheat	16.8	32.1
N_{40}	Sweet clover	11.3	19.8
	White mustard	19.3	31.9
	Oilseed radish	19.1	31.7
	Spring vetch	11.5	19.9
	Buckwheat	16.2	30.1
$P_{40}K_{40}$	Sweet clover	11.5	20.4
	White mustard	19.9	33.8
	Oilseed radish	19.9	34.5
	Spring vetch	11.8	20.7
	Buckwheat	17.0	32.8
$N_{40}K_{40}$	Sweet clover	11.3	19.4
	White mustard	19.0	30.5
	Oilseed radish	18.9	31.0
	Spring vetch	11.5	19.5
	Buckwheat	16.1	29.7
$N_{40}P_{40}$	Sweet clover	11.3	19.5
	White mustard	19.2	30.8
	Oilseed radish	19.0	30.8
	Spring vetch	11.5	19.6
	Buckwheat	16.2	29.1
$N_{40}P_{40}K_{40}$	Sweet clover	11.3	19.3
	White mustard	18.9	29.9
	Oilseed radish	18.8	30.1
	Spring vetch	11.5	19.5
	Buckwheat	16.0	28.7
$N_{80}P_{40}K_{40}$	Sweet clover	11.1	18.6
	White mustard	18.5	28.6
	Oilseed radish	18.3	28.8
	Spring vetch	11.2	18.8
	Buckwheat	15.7	27.6

There is an important issue of carbon and nitrogen ratio regarding the crops for green manure. The new formation of humic substances occurs in a more intense way, if the C:N ratio in the green manure biomass is 15:25. If the C:N ratio is under 15, the processes of biomass mineralization are accelerated, and if it is over 25 – the destruction of organic substances is slower. In both cases the formation of new humic substances is declined [4].

The aim of the research was to study the fluctuations in the content and stock of organic substances as well as the reaction of the soil environment depending on the impact of different types of fertilization of green manure crops.

MATERIALS AND METHODS

Field studies were conducted in conditions of an experimental field of Uman National University of Horticulture on podzolized heavy loamy chernozem, on loess. The agrochemical indices of the soil in experimental plots were as follows: humus content – increased, the content of nitrogen of alkali-hydrolyzed compounds, defined by Cornfield's method [5], – low, that of mobile compounds of phosphorus and potassium, defined by the modified method of Chirikov (DSTU 4115: 2002) – increased, the reaction of soil solution – weakly acidic. The three-replicate trials were set up according to the randomised complete-block design. The elementary plot size amounted 25 sq. m., while sown area was 36 sq. m.

Sweet clover, Donetskyi odnorichnyi cultivar, with the seeding rate of 20 kg/ha, white mustard Oslava – 20, oilseed radish Zhuravka – 20, spring vetch Yelyzaveta – 150, and buckwheat Antariya – 150 kg/ha were used as green manure with the following fertilization variants: no fertilizers – control; N_{40}; $P_{40}K_{40}$; $N_{40}K_{40}$; $N_{40}P_{40}$; $N_{40}P_{40}K_{40}$; $N_{80}P_{40}K_{40}$. The selection of crops was justified by their belonging to different biological groups and thus their different impact on soil fertility and yielding capacity of the subsequent crops. They also allow enhancing the biodiversity in the structure of a crop rotation and breaking the grain chain, typical for current field crop rotations in Ukraine.

The crops under study were sown on green-manured fallow. The crops were sown in late March (annual sweet clover, spring vetch, white mustard, oilseed radish)-mid May (buckwheat) in common drills. The previous crop was winter wheat.

The green manure crops were ploughed and incorporated into the soil at the depth of 25–27 cm in the phase of blossoming of sweet clover, the phase of blossoming – seed formation of buckwheat, the phase of blossoming – beginning of bean formation of spring vetch. The content of total carbon and nitrogen in them was defined by Anstett's method, modified by Ponomariova and Nikolayeva [5]; the content of total humus in the soil prior to sowing winter wheat (the activity year of green manure crops) – according to DSTU 4289:2004, pH of the water extract – according to DSTU ISO 10390:2007.

Mineral fertilizers were used in the following forms: ammonium nitrate (DSTU 7370:2013), granular superphosphate (GOST 5956-78), potassium chloride (GOST 4568-95).

The statistical processing of the data was conducted by dispersion analysis method according to Dospekhov [6].

RESULTS AND DISCUSSION

The increase in humus content in the soil due to green manure fertilization is commonly acknowledged [4, 7, 8], but some studies [9, 10] indicate significantly low ratio of C:N in green manure mass, which conditions their fast decomposition to final products without any humification.

The presented studies revealed that depending on crops, organs of green manure crops, and administration of different types and doses of mineral fertilizers, the carbon-nitrogen ratio changed from 11 to 35 (Table 1).

The administration of nitrogen fertilizers in the dose of 40 kg/ha of the active ingredient (a. i.) diminished the C:N ratio in the biomass and root remains by 2–4 and 2–6 % respectively, depending on the crop, and the very dose of nitrogen on the background of $P_{40}K_{40}$ – by 2–6 and 5–13 % respectively. Meanwhile the additional introduction of N_{40} on the background of $N_{40}P_{40}K_{40}$ diminished this index by 2–4 %. Phosphorous and potassic mineral fertilizers in the dose of 40 kg/ha of a.i. each did not have any considerable impact on nitrogen-carbon ratio in the green manure biomass.

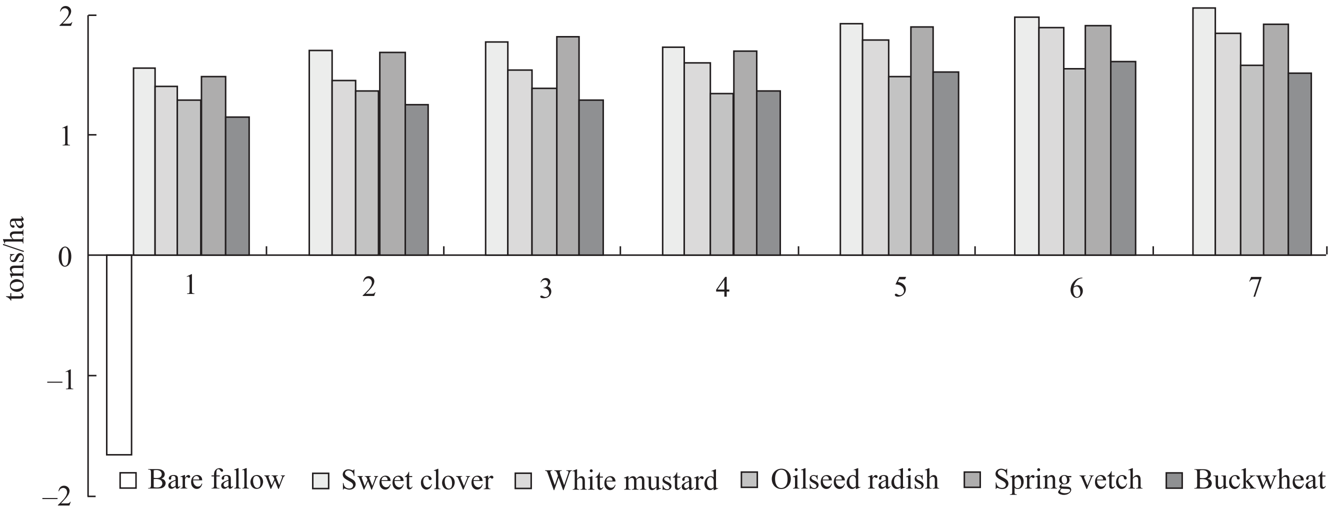
Thus, the lowest nitrogen-carbon ratio was registered in the biomass of the leguminous crops – 11.1–11.8, in the root remains – 18.8–20.7, whereas it was the highest in the root remains of the *Brassicaceae* crops – 28.8–34.5, depending on doses and types of mineral fertilizers. It testifies in favor of the data, obtained by other researchers [11] about possible considerable fluctuations in the C:N ratio, depending on the plant species (from 13 to 33), at the C:N ratio in the manure of 19–29 [12, 13].

The introduction of different doses and types of mineral fertilizers prior to green manure crops did not have any considerable impact on the humus content in the soil (Table 2).

Table 2. The impact of different types of green manure crops and their fertilization on the humus content in the 0–40 cm soil layer prior to sowing winter wheat (2013–2015), %

Variant of fertilization (factor A)	Soil layer, cm	Green manure crop (factor B)				
		Sweet clover	White mustard	Oilseed radish	Spring vetch	Buckwheat
No fertilizers (control)	0–20	3.11	3.11	3.11	3.11	3.11
	20–40	3.06	3.06	3.06	3.06	3.06
N_{40}	0–20	3.12	3.11	3.11	3.11	3.11
	20–40	3.06	3.06	3.06	3.06	3.06
$P_{40}K_{40}$	0–20	3.12	3.11	3.11	3.12	3.11
	20–40	3.06	3.06	3.06	3.06	3.06
$N_{40}K_{40}$	0–20	3.12	3.12	3.11	3.11	3.11
	20–40	3.06	3.06	3.06	3.06	3.06
$N_{40}P_{40}$	0–20	3.12	3.12	3.12	3.12	3.12
	20–40	3.06	3.06	3.06	3.06	3.06
$N_{40}P_{40}K_{40}$	0–20	3.10	3.12	3.12	3.12	3.12
	20–40	3.06	3.06	3.06	3.06	3.06
$N_{80}P_{40}K_{40}$	0–20	3.13	3.12	3.12	3.12	3.12
	20–40	3.06	3.06	3.06	3.06	3.06

Note. Humus content in the soil under bare fallow in the 0–20 cm soil layer – 3.08 %, 20–40 cm – 3.05 %. LSD_{05}: 2013 – A – 0.07: B – 0.06; AB – 0.17; 2014 –A – 0.08: B – 0.07; AB – 0.19; 2015 – A – 0.07: B – 0.06; AB – 0.15.



Humus balance in the 0–40 cm soil layer depending on the type of the fallow and fertilizers (2013–2015): 1 – no fertilizers (control); 2 – N_{40}; 3 – $P_{40}K_{40}$; 4 – $N_{40}K_{40}$; 5 – $N_{40}P_{40}$; 6 – $N_{40}P_{40}K_{40}$; 7 – $N_{80}P_{40}K_{40}$

The decrease in the level of humus intension of the soil by 0.01–0.04 % was observed both in the surface and subsurface layers in conditions of bare fallow compared to green-manured fallow. This result may be explained by the fact that during the first year the organic matter of green manure crops is mineralized by 60–80 %, whereas 10–30 % of it is transformed into humus and 3–8 % enters the biomass of microorganisms, meanwhile about the same amount is preserved in non-humified state [14].

The mineralization of 1.67 t/ha of humus was observed on the bare fallow plot on average for three years (Figure). The transformation of investigated green manure biomass allowed accumulating 1.15–2.05 t/ha of humus depending on doses and types of mineral fertilizers.

The administration of nitrogen fertilizers in the dose of 40 kg/ha of a. i. prior to different green manure crops increased the level of humus intensity of the soil by 0.04–0.19 t/ha compared to the variant without fertilizers, whereas phosphorus fertilizers in the dose of 40 kg/ha of a. i. in the composition of complete mineral fertilizer – by 0.20–0.29 t/ha, and potassic fertilizers – by 0.11 t/ha. The administration of N_{40} at the background of $P_{40}K_{40}$ and $N_{40}P_{40}K_{40}$ improved humus balance in the soil by 0.08–0.31 and 0.01–0.07 t/ha compared to the control, respectively. At the same time the additional administration of N_{40} at the background of $N_{40}P_{40}K_{40}$ prior to white mustard and buckwheat proved to be unreasonable due to the decrease in humus intensity by 0.04 and 0.08 t/ha, respectively.

The increase in the humus intensity of the soil after green-manured fallows may be explained both by biomass humification processes and low nitrogen to carbon ratio therein, which conditions the increase in the activity of soil microorganisms and the decomposition

Table 3. The isohumus index of different green manure crops depending on fertilization (2013–2015)

Fertilization variant	A green manure crop				
	Sweet clover	White mustard	Oilseed radish	Spring vetch	Buckwheat
No fertilizers (control)	1.68	1.52	1.52	1.68	1.60
N_{40}	1.67	1.54	1.53	1.68	1.61
$P_{40}K_{40}$	1.68	1.52	1.52	1.69	1.60
$N_{40}K_{40}$	1.69	1.52	1.55	1.68	1.61
$N_{40}P_{40}$	1.68	1.53	1.52	1.69	1.61
$N_{40}P_{40}K_{40}$	1.68	1.52	1.52	1.67	1.68
$N_{80}P_{40}K_{40}$	1.68	1.52	1.52	1.69	1.52

of mortmass of after-harvest remains of the previous crop (winter wheat). This is confirmed in the work [15], which states, "The best conditions for the development of humification process are in spring and in the beginning of summer. At this time the soil has sufficient reserves of moisture from autumn-winter precipitation and melting of snow, and favorable temperature regime. Microbiological processes are considerably weaker in the period of summer drought which protects humic substances from fast mineralization. The decomposition of plant remains, rich in ashy elements and nitrogen, leads to the formation of compounds (especially rich in calcium), which saturate humic substances. It promotes their fixation in the soil in the form of humates and their preservation in upper horizons of chernozem with neutral reaction. The elements of plant nutrition are fixed in the soil along with humus in the form of complex organo-mineral substances, formed due to the interaction of humic acids with ashy elements of plant remains and the mineral part of the soil".

Balance calculations of humus reserves in the soil also involve the use of isohumus coefficients – the amount of humus, formed in the soil from different organic materials (% per dry substance). This coefficient is 10 % for straw, 18 % for roots and plant root collars, 20–40 % – for humus, and 0 % – for young plants and green manure [16]. Zero index for green manure crops may mean the absence of lignin in them, which is directly related to the humification process. It is known

Table 4. The coefficient of green manure biomass humification depending on species specificities of plants and the nutrient status (2013–2015)

Fertilization variant	A green manure crop				
	Sweet clover	White mustard	Oilseed radish	Spring vetch	Buckwheat
No fertilizers (control)	1.68	1.52	1.52	1.68	1.60
N_{40}	1.67	1.54	1.53	1.68	1.61
$P_{40}K_{40}$	1.68	1.52	1.52	1.69	1.60
$N_{40}K_{40}$	1.69	1.52	1.55	1.68	1.61
$N_{40}P_{40}$	1.68	1.53	1.52	1.69	1.61
$N_{40}P_{40}K_{40}$	1.68	1.52	1.52	1.67	1.68
$N_{80}P_{40}K_{40}$	1.68	1.52	1.52	1.69	1.52
LSD_{05}					
2013	0.002	0.002	0.001	0.001	0.002
2014	0.002	0.002	0.001	0.001	0.002
2015	0.001	0.001	0.001	0.001	0.001

Table 5 The impact of green manure fertilization on soil acidity in the 0–20 cm layer prior to sowing winter wheat (pH_{wat}), 2013–2015

Fertilization variant	Bare fallow	A green manure crop				
		Sweet clover	White mustard	Oilseed radish	Spring vetch	Buckwheat
No fertilizers (control)	6.5	6.9	6.6	6.5	6.7	6.8
N_{40}		6.7	6.3	6.2	6.6	6.7
$P_{40}K_{40}$		6.8	6.6	6.4	6.8	6.8
$N_{40}K_{40}$		6.8	6.5	6.2	6.5	6.7
$N_{40}P_{40}$		6.9	6.4	6.3	6.7	6.8
$N_{40}P_{40}K_{40}$		7.0	6.3	6.2	6.7	6.9
$N_{80}P_{40}K_{40}$		6.9	6.4	6.3	6.6	6.9

that lignin is rather stable to decomposition, close to humic substances in its composition, and is the main source of soil humus [17]. However, it was established [18] that humus and humus-like substances may be formed from different organic remains even with low content of lignin in their composition. The content of lignin in dry mass of green manure crops is 4–11 %, and − 22 % in humus [14]. Therefore, green manure fertilization intensifies humification processes only during the first year. Further on the mineralization processes prevail over newly-formed humus and its losses are 0.003 % per year on average [19]. Thus, if humus balance is calculated by the method of isohumus coefficients not for the year of introducing green manure crops, but rather for a longer period of time, the result may be mistakenly interpreted as the absence of positive impact of this process on humus state of soils.

The results of studies demonstrate that the isohumus index was not significantly influenced by doses and types of fertilizers, it changed depending on the species of plants, used for green manure (Table 3).

When the *Cruciferae* family (white mustard and oilseed radish) are used as green manure, the isohumus index is 1.52–1.55, 1.67–1.69 – for the *Leguminosae* (annual sweet clover and spring vetch), and 1.52–1.60 – for buckwheat, depending on fertilization.

The results of studies demonstrate that the humification coefficient for raw green manure biomass depends on the species of plants, used for green manure, and their fertilization (Table 4).

The humification coefficient for the biomass of oilseed radish was 0.023, for spring vetch – 0.027, for buckwheat – 0.033, for white mustard – 0.035, and for annual sweet clover – 0.036 on the plots without any fertilizers. The administration of different doses and types of mineral fertilizers conditioned the decrease in the coefficient of green manure humification. The lowest humification index was observed in the experiment variant with the introduction of the maximal dose of fertilizers ($N_{80}P_{40}K_{40}$) – 0.020–0.034 depending on the green manure crop. The administration of only phosphorus and potassium fertilizers ($P_{40}K_{40}$) had no significant impact on this index. According to the data of other researchers, the humification coefficient of the biomass is mostly dependent on the C:N ratio in the biomass and the ontogenesis stage of green manure fertilizers [20].

It was determined that the value of active acidity of the soil (pH of the water suspension) in the 0–20 cm layer at the time of the fallow in the variant without any fertilizers was 6.5–6.9, and 6.5 – for bare fallow (Table 5).

On average during three years of studies, the index of pH_{wat} after fertilized green manure crops for the period of sowing winter wheat was at the level of 6.2–7.0 depending on the experiment variant. Therefore, the introduction of green manure crops to the soil triggers the neutralization of the negative impact of physiologically acid mineral fertilizers. A considerable difference in the impact was established between the introduction of mineral fertilizers for the green-manured fallow with annual sweet clover, buckwheat, and oilseed radish.

The decrease in active acidity of the soil after green-manured fallows is explained by the transfer of calcium from lower layers to the surface layer of soil by the root system. The correlation analysis revealed an insignificant connection between the active acidity of the soil and the input of calcium into root-containing layer together with the green manure biomass for annual sweet clover, white mustard and oilseed radish (R^2 = 0.27; 0.25; 0.20, respectively), moderate connection – for buckwheat (R^2 = 0.40), and its absence was registered for spring vetch (R^2 = 0.02).

CONCLUSIONS

The application of green manure both with and without fertilizers compared to bare fallow promotes the preservation of humus content in the soil. The transfer of calcium from lower layers to the arable soil layer, performed by the plant root system in green-manured fallow, decreases the active acidity of the soil.

Зміни в органічній частині ґрунту та кислотно-основної рівноваги залежно від удобрення сидератів на чорноземі опідзоленому

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Мета. Вивчити зміни вмісту і запасів органічних речовин, а також реакцію ґрунтового середовища залежно від впливу різноудобрених сидеральних парів. **Методи.** Застосовано польові методи дослідження на чорноземі опідзоленому важкосуглинковому на лесі за умов Правобережного Лісостепу України. В сидеральних парах використано буркун білий з нормою висіву насіння 20 кг/га, гірчицю білу – 20, редьку олійну – 20, вику яру – 150 та гречку – 150 кг/га за таких варіантів удобрення: без добрив – контроль; N_{40}; $P_{40}K_{40}$; $N_{40}K_{40}$; $N_{40}P_{40}$; $N_{40}P_{40}K_{40}$;

$N_{80}P_{40}K_{40}$. Вміст загального вуглецю і азоту визначено методом Анстета в модифікації Пономарьової і Ніколаєвої; вміст загального гумусу в ґрунті перед сівбою пшениці озимої (дія сидератів протягом року) – згідно з ДСТУ 4289:2004, pH водної витяжки – згідно з ДСТУ ISO 10390:2007. **Результати.** Азотно-вуглецеве співвідношення в фітомасі бобових культур становило від 11,1 до 11,8 і в кореневих рештках від 18,8 до 20,7, а найвище його значення спостерігалося в кореневих рештках капустяних культур від 28,8 до 34,5 залежно від доз і видів мінеральних добрив. Сидерація порівняно з чистим паром сприяє збереженню гумусу в ґрунті. За умов чистого пару зафіксовано зниження рівня гумусованості ґрунту як в орному, так і підорному його шарах на 0,01–0,04 % порівняно з сидеральними парами. В ґрунті за чистого пару мінералізується 1,67 т/га гумусу. Трансформація біомаси сидератів дозволяє накопичувати 1,15–2,05 т/га гумусу залежно від доз і видів мінеральних добрив. За застосування як сидератів культур родини капустяних (гірчиці білої і редьки олійної) ізогумусовий показник становить 1,52–1,55, родини бобових (буркуну білого однорічного і вики ярої) – 1,67–1,69, гречки – 1,52–1,60 залежно від удобрення. Коефіцієнт гуміфікації рослинної біомаси редьки олійної дорівнює 0,023, вики ярої – 0,027, гречки – 0,033, гірчиці білої – 0,035 та буркуну білого однорічного – 0,036. Внесення різних доз і видів мінеральних добрив зумовлює зменшення коефіцієнта гуміфікації сидератів. **Висновки.** Застосування сидеральних парів як на тлі удобрення, так і без добрив порівняно з чистим паром сприяє збереженню вмісту гумусу в ґрунті. За сидеральних парів відбувається переміщення кальцію кореневою системою рослин з нижніх шарів до орного шару ґрунту, в результаті чого знижується активна кислотність ґрунту.

Ключові слова: сидерати, мінеральні добрива, гумус, ізогумусовий показник, C:N, кислотність.

Изменения в органической части почвы и щелочно-основного равновесия в зависимости от удобрения сидератов на черноземе оподзоленном

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Цель. Изучить изменения содержания и запасов органических веществ, а также реакцию почвенной среды в зависимости от влияния разноудобренных сидеральных паров. **Методы.** Применены полевые методы исследования на черноземе оподзоленном тяжелосуглинковом на лессе в условиях Правобережной Лесостепи Украины. В сидеральных парах использовали донник белый с нормой высева семян 20 кг/га, горчицу белую – 20, редьку масличную – 20, вику яровую – 150 и гречиху – 150 кг/га при таких вариантах удобрения: без удобрений – контроль; N_{40}; $P_{40}K_{40}$; $N_{40}K_{40}$; $N_{40}P_{40}$; $N_{40}P_{40}K_{40}$; $N_{80}P_{40}K_{40}$. Содержание общего углерода и азота выявляли методом Анстета в модификации Пономаревой и Николаевой; содержание общего гумуса в почве перед посевом пшеницы озимой (действие сидератов в течение года) – согласно ДСТУ 4289:2004, pH водной суспензии – согласно ДСТУ ISO 10390:2007. **Результаты.** Азотно-углеродное соотношение в фитомассе бобовых культур составляет от 11,1 до 11,8 в корневых остатках от 18,8 до 20,7, а наивысшее его значение в корневых остатках капустных культур от 28,8 до 34,5 в зависимости от доз и видов минеральных удобрений. Сидерация по сравнению с чистым паром способствует сохранению гумуса в почве. В условиях чистого пара наблюдается снижение степени гумусированности почвы как в пахотном, так и подпахотном его слоях на 0,01–0,04 % по сравнению с сидеральными парами. В почве чистого пара минерализуется 1,67 т/га гумуса. Трансформация биомассы сидератов позволяет накапливать 1,15–2,05 т/га гумуса в зависимости от доз и видов минеральных удобрений. При применении в качестве сидератов культур семейства капустных (горчицы белой и редьки масличной) изогумусный показатель составляет 1,52–1,55, семейства бобовых (донника белого однолетнего и вики яровой) – 1,67–1,69, гречихи – 1,52–1,60 в зависимости от удобрения. Коэффициент гумификации растительной биомассы редьки масличной равен 0,023, вики яровой – 0,027, гречихи – 0,033, горчицы белой – 0,035 и донника белого однолетнего – 0,036. Внесение различных доз и видов минеральных удобрений приводит к уменьшению коэффициента гумификации сидератов. **Выводы.** Применение сидеральных паров как на фоне удобрения, так и без удобрений по сравнению с чистым паром способствует сохранению содержания гумуса в почве. В сидеральных парах происходит перемещение кальция корневой системой растений с нижних слоев почвы в пахотный слой, в результате чего снижается активная кислотность почвы.

Ключевые слова: сидераты, минеральные удобрения, гумус, изогумусный показатель, C:N, кислотность.

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