UDC 631.468:631.86

RESTORING THE FERTILITY OF CHERNOZEMS OF FOREST-STEPPE IN MODERN AGRICULTURE

A.D. Balayev, Doctor of Agricultural Sciences, professor
O.L. Tonkha, Candidate of Agricultural Science, associated professor[1]

Restoration of chernozems fertility is achieved through minimization of soil tillage and application of organic and mineral fertilizers using byproducts. The use of deep soil conservation tillage and of organic fertilizers, increases in the 0-40 cm layer the number of bacteria that are involved in the synthesis of melanin on 12-85 %, organic matter content on 0,15 %, and reduces the number of humat-decomposing microorganisms in two times.

Pedotrophic microorganisms, deep soil conservation tillage, chernozem fertility restoration.

The soil cover of Ukraine is able to provide high performance crop rotation due to the large proportion of chernozems in its structure. At present, most of the crop production in Ukraine is obtained through the intensive use of soil fertility potential. This primarily applies to chernozems as the most fertile soil on which more than two-thirds of agricultural products are produced. Only due to the fertility of these soils, our state provides domestic food needs and has the ability to export a significant proportion of grain on the world market even using minimum fertilizers. If we do not change this state of affairs, it is clear tendency to a gradual depletion of our best soils. It would be too dangerous to continue this practice knowing that, after a certain limit deterioration , soil can become infertile [3,4].

The main directions of reducing of mechanical and chemical loading on soils and provide them agricultural law of returning nutrients and organic compounds is soil tillage minimizing and biologizing of agriculture [3]. The combination of these two trends is the use of resource-saving technologies of soil cultivation , based on refusing of deep plowing and use of deep soil conservation tillage using organicfertilizers as straw, green manure and by-products. The most important indicator of chernozems fertility restoration and criteria for evaluating the effectiveness of technological measures is the content of organic matter, quantity and

species composition of microorganisms. Using these same parameters also restoration of soil fertility can be measured.

The purpose of research was to study the parameters of humus and biological activity in chernozem typical under influence of various technologies of crop growing.

Research Methodology. The object of research is the process of biological transformation of organic matter in chernozem typical under different technologies of crop growing, the number of pedotrophic, humat-decomposing, melanin-synthesizing microorganisms.

Field studies were conducted in the period of 2007-2012 on chernozem typical medium-loamy on loess on the long-term field research of the department of soil science and soil conservation named after M.K.Shykula, that began from 1998 in Scientific -Research farm (SRF) "Velykosnitynske named after O. Muzychenko" Fastiv district of Kiev region. Research was conducted in the next rotation : 1. Soybean. 2. Winter wheat. 3. Maize for grain. 4. Barley.

Research was conducted on three different tillage systems :

1. Traditional , based on deep plowing to 25-27 cm
2. Soil conservation, based on different depth conservation tillage to 25-27 cm
3. Soil conservation, based on shallow soil conservation tillage to 10-12 cm

When planning a system of fertilization, emphasis was on the use of local resources - straw and green manure cultivation. We investigate the effect of fertilization variants: 1.Control (without fertilizers). 2.Straw 1.2 t/ha + N_{12} + green manure + $N_{78}P_{68}K_{68}$.

Soil and biological studies were conducted during the active growing season (May) in the 0-5 , 5-20 , 20-40 – cm soil layers. Sampling, preparation and storage of soil samples for the study of aerobic microbiota in vitro was performed according to EN ISO 10381 - 6-2001. Determining the number of different groups of soil microorganisms was performed according to the method of D.G. Zvyagintsev [6], by planting soil suspensions on solid nutrient media. In meat- peptone agar (MPA) was studied the total number of microorganisms that decompose organic compounds that

contain nitrogen. On starch -ammonium medium (SAA) were studied microorganisms that assimilate mineral forms of nitrogen.

Results. Application of different types of organic fertilizers and soil conservation tillage is a key condition of non-deficit balance of humus and expanded reproduction of soil fertility. With the systematic application of these measures reserves of humus increase, improving its quality, and non-deficit balance is achieved at a reasonable standards of organic fertilizers. Thus, if in the Forest-Steppe zone, non-deficit balance of humus in typical rotation under plowing is achieved with the introduction of 10-12 t of manure per 1 ha of crop rotation , under non-plowing conservation tillage is achieved at 7.5 t/ha.

According to our data in the soils all soil -climatic zones of Ukraine is the ability to provide non-deficit balance of humus when used as organic fertilizer by-products (Table 1).

1 **Capability of organic fertilizers to ensure a non-deficit balance of humus in soils of different subzones of Ukraine, t/ha of crop rotation**

Zone, subzone	Norms of manure application for non-deficit balance of humus		Averagepossibility of organic fertilizers production from secondary part of yield, crop residues, siderates							
	plowing	soil conservation tillage	straw of grains	stems of corn	stems of sunflower	leaves of beets, potatoes etc.	ltubble	residues of perennial grasses	siderates	totally, in recalculation for manure
Southern Steppe	7	5	1,3	0,5	0,3	0,1	0,5	0,5	0,1	14,0
Northern Steppe	9	6	1,8	0,8	0,4	0,1	0,7	0,7	0,5	20,0
Eastern and Central Forest-Steppe	11	7	1,5	0,7	0,5	0,2	0,9	1,0	2,0	20,0
Western Forest-	13	9	1,4	0,7	0,4	0,2	0,9	1,2	2,5	21,0

Steppe Eastern and Central	15	10	-	-	-	0,5	0,3	2,3	2,7	11,0
Forest Western Forest	17	11	-	-	-	0,5	0,4	2,5	3,0	12,0

Moreover, the performance capabilities of these organic fertilizers in all areas far exceed the required standards of manure for soil fertility restoration.Humus mainly accumulates in the upper 0-30 cm soil layer , which improves its agrophysical properties. Mulch , which covered the surface of the soil in such technologies is protective, moisture-saving and against-erosion role. Due to better humifying of upper layers of the soil under non-plowing conservation tillage, soil biogenity increases, enhanced transformation function and thus increases the capacity for self-regulation.

Microorganisms play an important role in soil formation and soil evolution, shaping their fertility cleanse itself from chemical contaminants, pathogens and toxins. They perform functions that ensure the continuity of the soil as a complex self-regulating system. The most important of these are involved in humus formation and transformation of fresh organic matter cycle of carbon, nitrogen and other elements. Pedotrophic and humat-decomposing microorganisms are involved in decomposition of nuclear and peripheral parts of humic substances. Table 2 shows the effects of different tillage and fertilization on the number of pedotrophic and humat-decomposing microorganisms.

2. Effect of different options of tillage and fertilization on the content of humat-decomposing, pedotrophic vicroorganisms and pedotrophic index in chernozem typical low-humified

Fertilizing option	Tillage option	Soil layer, cm	Humat-decomposing microorganisms, mln CFU/g	Pedotrophic microorganisms, mln CFU/g	Pedotrophic index
Control (no fertilizers)	Plowing	0–20	5,7±0,09	2,9±0,50	0,36
		20–40	2,1±0,19	3,3±0,06	0,23
		0–40	3,9±0,17	3,1±0,23	0,29
	Shallow non-plowing cultivation	0–20	6,5±0,14	3,9±0,28	0,34
		20–40	5,7±0,30	5,8±0,43	0,64
		0–40	6,2±0,33	4,6±0,39	0,48

Straw 1,2 t/ha + N12 + siderates + $N_{78}P_{68}K_{68}$	Different-depth non-plowing cultivation	0–20	6,7±0,37	7,8±0,29	0,70
		20–40	1,7±0,07	2,7±0,09	0,12
		0–40	4,5±0,35	5,3±0,15	0,41
	Plowing	0–20	4,6±0,17	7,5±0,19	0,50
		20–40	5,1±0,16	13,7±0,46	0,90
		0–40	4,8±0,16	10,5±0,39	0,74
	Shallow non-plowing cultivation	0–20	3,4±0,32	10,7±0,45	1,02
		20–40	5,2±0,49	1,5±0,29	0,50
		0–40	4,3±0,32	7,1±0,41	0,76
	Different-depth non-plowing cultivation	0–20	2,6±0,17	11,7±0,07	1,05
		20–40	2,2±0,16	5,5±0,37	0,67
		0–40	2,4±0,15	8,6±0,28	0,86
Deposit land		0–20	1,6±0,09	6,4±0,15	0,95
		20–40	2,4±0,12	3,7±0,15	0,77
		0–40	1,9±0,11	5,1±0,23	0,86

At control the number of humat-decomposing microorganisms was the highest in the 0-20 cm layer, as in plowing, and under non-plowing cultivations. Due to lack of "fresh organic matter " in chernozem typical a significant development of humat-decomposing microorganisms occured, which were in 1,5-2 times more than in fertilized options. Fertilization contributed to a significant reduction of thet microorganisms, especially under non-plowing cultivations. Number of pedotrophic microorganisms increased after fertilization, indicating the presence of readily available soil organic matter. Pedotrophic Index, which, by definition of the authors [4], determines the degree of development of the organic matter, in 0-40 cm layer was the highest under different-depth non-plowing cultivation , and on 15% lower than under the shallow non-plowing and the smallest - under plowing .

Cyclic molecules of melanin, by definition E.M. Myshustyn [6], can serve as a basis for the completion of the peripheral components of humic compounds. In Fig. 1 shown the number of bacteria that are involved in the synthesis of melanin, and the number is dependent on the cultivation of the soil and fertilizers.

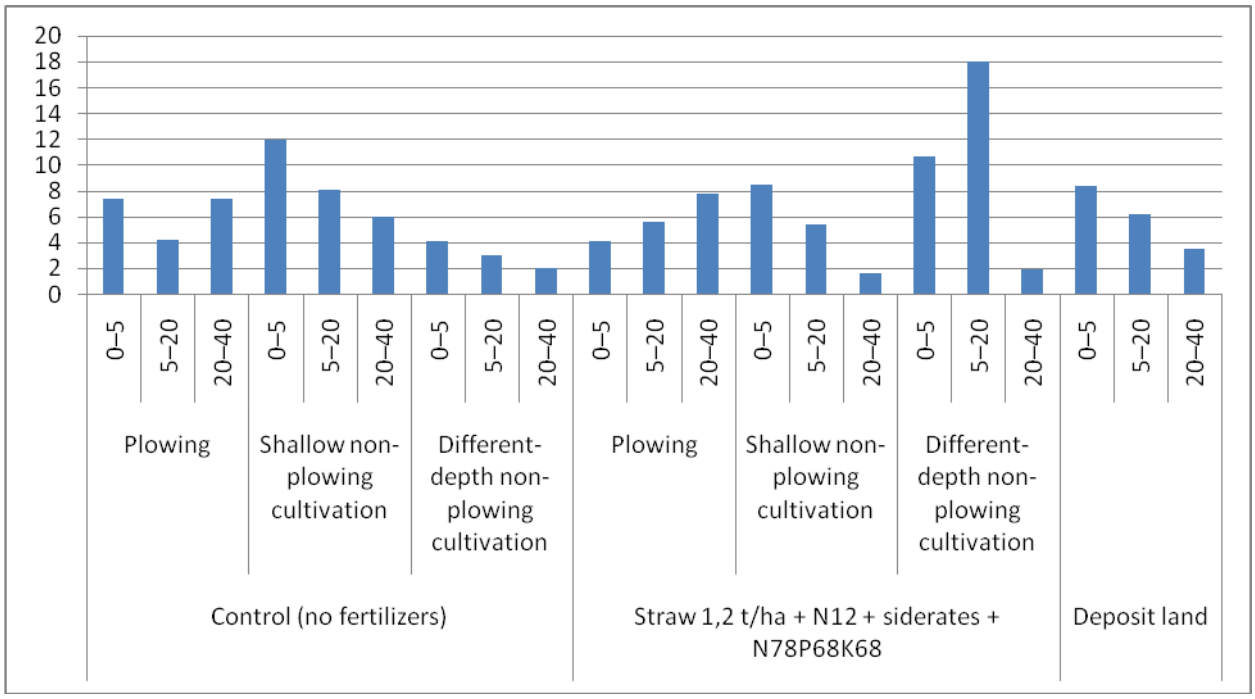

Figure. The number of microorganisms, involved in the synthesis of melanin in chernozem typical low- humified , million CFU / g of soil

Thus, the variant without fertilizers shown the highes parameres under shallow non-plowing cultivation in 0-5 cm soil layer, and in fertilized option the highest parameters were in 5-20 cm layer. The number of microorganisms in soil conservation technology with elements of biologization was higher on 12-85 % compared with plowing. Deposit land was not characterized by high values and the values decreased from 0-5 to 20-40 cm layer.

Content of humus and organic matter depended both on fertilization, and on soil tillage. Use as organic fertilizers straw and green manure (siderates) cause increasing of humus content in all options of tillage (table 3).

3. Contain of organic matter and humus in chernozem typical low-humified depending on the fertilizing system and tillage, %

Fertilizing option	Tillage option	Soil layer, cm			
		0–20		20–40	
		organic matter	humus	organic matter	humus
Plowing	Control –no fertilizers	3,40	3,18	3,10	3,05

	Straw 1,2 t/ha + N_{12} + siderates + $N_{78}P_{68}K_{68}$	4,09	3,93	4,12	3,92
Shallow non-plowing cultivation	Control (no fertilizers)	3,47	3,28	3,09	2,93
	Straw 1,2 t/ha + N_{12} + siderates + $N_{78}P_{68}K_{68}$	4,34	4,10	4,00	3,83
Different-depth non-plowing cultivation	Control (no fertilizers)	3,50	3,26	3,13	3,01
	Straw 1,2 t/ha + N_{12} + siderates + $N_{78}P_{68}K_{68}$	4,40	4,13	4,12	3,95
Deposit land		4,48	4,18	4,20	4,00

$HIP_{0,5}$ =0,04–0,06

The difference between the layers in deposit land and variants of field research increased in the lower part of soil profile. In tillage options the best was different-depth non-plowing cultivation, because it allowed to collect and store organic matter in the upper soil layer. Under plowing organic fertilizers are incide soil, that causes fast decomposition of organic matter and its collection only in 0–40 cm soil layer.

Conclusions

Restoration of chernozems fertility is achieved through minimization of tillage and the inclusion of organic fertilizers using byproducts. The use of deep non-plowing cultivation using organic fertilizers causes increasing in the 0–40 cm layer the number of bacteria that are involved in the synthesis of melanin on 12–85%, organic matter content on 0,15 % and reduces the number of humat-decomposing microorganisms in two times comparing with deep plowing.

References

1. Zvyahyntsev D.G. Methods of soil microbiology and biochemistry: study guide/ D.G. Zvyahyntsev.–M. : MSU, 1991.–304p /in Russian.

2. Mishustin E.N. |Microorganisms and crop growing productivity / E.N. Mishustin . - Moscow: Nauka, 1972. - 342 p./ in Russian

3. Nosko B.S. Features of human evolution of nutrient regime of chernozems / B.S. Nosko //Bulletin KHNAU . - 2008. - № 1. - P. 79–84 ./In Ukrainian

4. Tanchyk S.P. Efficiency of agriculture in Ukraine / / Bulletin of Agricultural Science. - 2009. - № 12. - P. 5-11 ./ In Ukrainian

5.Tykhonenko D.G. Biological characteristics of light soils of different edaphotops. / Tykhonenko D.G., L.I. Vasilieva / / Sb.tr. Kharkov . agricult. un-ty. Kh – 1976. - P.102 -109. /in Russian

6. Poljovyy V.M. Features of agrochemical soil degradation depending on fertilization / / Bulletin of Agricultural Science. - 2005. - № 3. - P. 23-25.

7. Functioning of soil microbial communities under anthropogenic load / [K.I. Andreyuk , G.A. Iutynska , A.F. Antypchuk et al.] - K.: Oberegy, 2001. - 24 p./ In Ukrainian