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ACTIVE COLLOIDAL HUMUS IN STANDARDS OF INTENSITY INDICATOR AND DIRECTION OF MICROBIOLOGICAL PROCESSES OF SOIL FORMATION

Research article

Abstract

Nonlinear models were constructed in work on established relationships between the indicators of the intensive direction of soil formation processes and colloidal active humus enabling the classification of landings about the cultivation of soils and their genesis. Transformation models of organic matter of the upper soil horizons were developed under the influence of agricultural use depending on (the activity of chemoorganotrophic bacteria and actinomycetes) their genesis.

Keywords: soil, humus, microorganisms, agricultural use, standards.

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АКТИВНЫЙ КОЛЛОИДНЫЙ ГУМУС В СТАНДАРТАХ ПОКАЗАТЕЛЯ ИНТЕНСИВНОСТИ И НАПРАВЛЕННОСТИ МИКРОБИОЛОГИЧЕСКИХ ПРОЦЕССОВ ПОЧВООБЗАЗОВАНИЯ

Научная статья

Аннотация

В работе по установленным связям между показателями интенсивной направленности почвообразовательных процессов и коллоидного активного гумуса построены нелинейные модели, позволяющие классифицировать угодия с учетом окультуренности почв и их генезиса. А также разработаны модели трансформации органического вещества верхних горизонтов почв под воздействием сельскохозяйственного использования в зависимости от (активности хемоорганотрофных бактерий и актиномицитов) их генезиса.

Ключевые слова: почва, гумус, микроорганизмы, сельскохозяйственное использование, стандарты.

1. Introduction

In order to preserve the fertile soil layer over time, the solution of one of the most important tasks of agriculture becomes even more urgent. Namely, the increase in the capacity of the biological cycle, the involvement of new nutrients in it to increase crop yields. To improve the agronomic properties of the soil, it is cultivated by introducing organic and mineral fertilizers, which leads to an increase in its fertility. In this regard, the most essential quality of humus should be noted – its colloid characteristics. It makes small additions of humus substances to the soil-forming rock more fertile. If we consider humus formation in typical soils, then its most significant amount is contained in black soil. But with changes in climatic conditions and the nature of vegetation, its reserves are reduced [1, p.26]. The basis of this work was formed with the help of long-term studies of the authors [1-13], covering a 20-year period of research.

The aim of our work is to establish the relationship between the standards of soil formation processes related to soil zonality and the activity of colloidal humus.

2. Materials and methods

To build models of active humus (Ag) dynamics from the indicator of the intensity and direction of microbiological processes of soil formation (PIN), the least squares method (OLS) was used.

To achieve this goal, the following tasks were solved:

- the release of active colloidal humus according to typical zonal soils (Table 1);
- establishing the relationship between the indicator characterizing the processes of soil formation and colloidal active humus about the soil culture (Models (1) - (3)).

The release of active colloidal humus according to typical zonal soils is presented (Table 1).

With an increase in the number of microorganisms on MPA and KAA, the soil microbiological activity increases, i.e. accelerated soil formation processes. The direction of the processes is responsible for the value of MPA: KAA, the smaller the ratio, the stronger the mineralization of organic matter, and vice versa. Therefore, it is advisable to consider their simultaneous influence on the intensity and direction of microbiological processes as a whole, which is expressed in indicators of the PIN.

Table 1, soil zonality column includes the following notation:

SM - soddy mesopodzol soil; LG - light gray soil; TB - typical black soil; DS - dark chestnut slightly-alkalinized soil; KF - red-yellow typical ferralitic soil. PIN is an indicator of the intensity and direction of microbiological processes of soil formation.

Table 1 - Transformations of Organic Matter in the Upper Soil Horizons under the Influence of Agricultural Use

Soil	Soil Zonality	Humus, total %	$\frac{АГ}{ПГ}$	AG
1	2	3	4	5
Virgin soil, Forest, Deposit for more than 50 years	SM LG TB TC KF	2,21 3,1 7,05 4,63 6,01	0,16 0,26 0,33 0,53 0,02	0,3 0,64 1,75 1,6 0,12
Σ	5 Types	23	1,3	4,41
Arable land	SM LG TB TC KF	2,03 1,68 5,25 3,11 2,97	0,47 0,58 0,67 0,93 0,11	0,65 0,61 2,1 1,5 0,297
Σ	5 Types	15,04	2,76	5,157
Cultivated arable land	SM LG TB TC KF	2,65 2,79 5,65 3,30 4,56	0,61 0,64 0,71 1,14 0,07	1,01 1,09 2,35 1,76 0,299
Σ	5 Types	18,95	3,17	6,509

The method of least squares aligns experimental data on the parabola.

Let us establish the relationship between the indicator characterizing soil formation process and colloidal active humus concerning soil cultivation (models (1) - (3)). To do this, we compose a system of linear equations for the parameters a, b, c using the data for calculations in Table 2.

$$\begin{cases} a\Sigma x_i^4 + b\Sigma x_i^3 + c\Sigma x_i^2 = \Sigma x_i^2 y_i \\ a\Sigma x_i^3 + b\Sigma x_i^2 + c\Sigma x_i = \Sigma x_i y_i \\ a\Sigma x_i^2 + b\Sigma x_i + cn = \Sigma y_i \end{cases}$$

Table 2 - Scheme for Calculating the Dependence of Ag (y) on the PIN (x) for Virgin Soil

p/p	x_i	y_i	$x_i y_i$	x_i^2	$x_i^2 y_i$	x_i^3	x_i^4	Y_i	εi	ε_i^2
1	1,32	0,3	0,396	1,7424	0,25272	2,2999	3,036	0,96	0,16	0,0256
2	2,31	0,64	1,4784	5,3361	3,4151	12,3264	28,4739	0,67	0,03	0,0009
3	9,40	1,75	16,45	88,36	154,63	830,584	7807,49	1,489	-0,25	0,0625
4	10,27	1,6	16,432	105,4729	168,7566	1083,21	11124,53	1,50489	-0,09	0,0081
5	20,86	0,12	2,5032	435,1396	52,2168	9077,012	189346,47	0,215	0,095	0,0090
Σ	44,16	4,41	37,2596	636,051	379,5412	11005,43	208309,99			0,106125

$$\begin{cases} 208310a + 11005{,}43в + 636{,}1c = 379{,}54 \\ 11005{,}43a + 636{,}1в + 44{,}16c = 37{,}26 \\ 636{,}1a + 44{,}16в + 5c = 4{,}41 \end{cases}$$

Solving the system with the help of the Gauss-Jordan method, we find the unknown parameters of the model.

$$\left(\begin{array}{ccc|c} 1 & 0{,}053 & 0{,}003 & 0{,}0018 \\ 0 & 52{,}87 & 11{,}14 & 15{,}249 \\ 0 & 10{,}45 & 3{,}092 & 3{,}148 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & -0{,}0081 & -0{,}0134 \\ 0 & 1 & 0{,}21 & 0{,}288 \\ 0 & 0 & 0{,}899 & 0{,}128 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & 0 & -0{,}0122 \\ 0 & 1 & 0 & 0{,}258 \\ 0 & 0 & 1 & 0{,}142 \end{array}\right)$$

a=-0,0122; в=0,258; c=0,142

Ag=-0,0122x2+0,258x+0,142 (1)

We estimate the error by the formula $\varepsilon = \frac{\sqrt{\sum_{i=1}^{n} \varepsilon_i^2}}{n} = \frac{\sqrt{0{,}106125}}{5} = 0{,}065$

To determine the effect of soil formation standards on colloidal active humus - AG, we look at the data in Table 1 for arable land.

We act the same way, using the data in Table 3 for the calculation, we obtain Model (2) with the error estimate.

Table 3 - Scheme for Calculating by the Method of Least Squares Ag (y) from the PIN (x) for Arable Land

p/p	x_i	y_i	$x_i y_i$	x_i^2	x_i^3	x_i^4	$x_i^2 y_i$	Y_i	εi	ε_i^2
1	0,64	0,65	0,416	0,4096	0,2621	0,1677	0,26624	1,075	-0,425	0,180625
2	2,28	0,61	1,3908	5,1984	11,8524	27,0234	3,171024	1,13	-0,52	0,2704
3	8,73	2,1	18,333	76,2129	665,3386	5808,4061	160,04583	1,252	0,848	0,719104
4	10,58	1,5	15,87	111,9364	1184,2871	12529,7576	167,9046	1,259	0,241	0,058081
5	31,60	0,297	9,3852	998,56	31554,496	997122,0736	296,5723	0,4424	-0,1454	0,02114
Σ	53,83	5,157	45,395	1192,3173	33416,2362	1015487,428	627,960014	5,1584		1,249346

$$\begin{cases} 1015487{,}428a + 33416{,}2362в + 1192{,}3173c = 627{,}960014 \\ 33416{,}2362a + 1192{,}3173в + 53{,}83c = 45{,}395 \\ 1192{,}31{,}73a + 53{,}83в + 5c = 5{,}157 \end{cases}$$

$$\left(\begin{array}{ccc|c} 1 & 0{,}033 & 0{,}00112 & 0{,}00062 \\ 0 & 189{,}83 & 16{,}4038 & 24{,}6769 \\ 0 & 14{,}48 & 3{,}6646 & 4{,}4177 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & -0{,}0033 & -0{,}00367 \\ 0 & 1 & 0{,}146 & 0{,}12999 \\ 0 & 0 & 0{,}672 & 2{,}5354 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & 0 & -0{,}00185 \\ 0 & 1 & 0 & 0{,}0392 \\ 0 & 0 & 1 & 1{,}051 \end{array}\right)$$

a= -0,00185; в=0,0392; c=1,051; ε =0,224

Ag= -0,00185x2+0,0392x+1,051 (2)

Similarly, we construct a model using data in Table 4 for cultivated arable land.

Table 4 - Scheme for Calculating Ag (y) from PIN (x) for Cultivated Arable Land

p/p	x_i	y_i	$x_i y_i$	x_i^2	x_i^3	x_i^4	$x_i^2 y_i$	Y_i	εi	ε_i^2
1	2,9	1,01	3,91	8,41	24,39	70,73	8,4941	1,069	0,059	0,0035
2	3,83	1,09	4,18	14,67	56,18	215,18	15,9903	1,242	0,152	0,0231
3	9,61	2,35	22,58	92,35	887,50	8528,91	217,0225	2,092	-0,257	0,0664
4	14,82	1,76	26,08	219,63	3254,95	48238,39	386,5488	2,525	0,7654	0,5858
5	36,38	0,299	10,88	1323,50	48149,09	1751663,89	395,7265	1,0467	0,7476	0,559
Σ	67,54	6,509	67,63	1658,56	52372,11	1808717,1	1023,7822			1,2378

$$\begin{cases} 1808717{,}1a + 52372{,}11в + 1658{,}56c = 1023{,}7822 \\ 52372{,}11a + 1658{,}56в + 67{,}54c = 67{,}63 \\ 1658{,}56a + 67{,}54в + 5c = 6{,}509 \end{cases}$$

$$\left(\begin{array}{ccc|c} 1 & 0{,}029 & 0{,}0009 & 0{,}00057 \\ 0 & 139{,}77 & 20{,}41 & 37{,}78 \\ 0 & 19{,}44 & 3{,}51 & 5{,}5636 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & -0{,}0033 & -0{,}00726 \\ 0 & 1 & 0{,}146 & 0{,}27 \\ 0 & 0 & 0{,}672 & 0{,}3148 \end{array}\right) \sim \left(\begin{array}{ccc|c} 1 & 0 & 0 & -0{,}0057156 \\ 0 & 1 & 0 & 0{,}224 \\ 0 & 0 & 1 & 0{,}468 \end{array}\right)$$

Ag= -0,00572 x2+0,224x+0,468; $\varepsilon = 0{,}223$ (3)

Thus, models have the form of a parabola = ax2 + ix + s; where Ag-y; x - PIN - respectively, the branches of which are directed downwards; this indicates limited humus as a resource potential.

Ag = -0,0122 PIN2 +0.258 PIN + 0.142

Comparing the transformation matrices of soil procedures associated with the activity of microorganisms and humus with the parental matrices [11], depending on the age of the person, we obtain an amazing coincidence in value - productivity, falling on a certain period from 1 to 15 years; from 15 to 40 years; from 40 to 46 years. The dynamics of organic substances transformation in the upper soil horizons under the influence of agricultural use in the total humus in% covers the period from 15 to 46 years and from 3 years to 66 years in microbiological processes. We include the age, height, weight, intelligence [13-15] in the matrix of transformation dynamics in human development.

Thus, if we compare growth with soil zonality, weight with indicators of activity of microbiological processes, intelligence with humus, and age with the development of temporary matrices for humus and microbiological activity, then we understand the development of a person with the development of soil formation processes we approach the understanding of our appearance as a species with the power that is able to change the world around us through the noosphere, in accordance with certain standards of interconversion.

3. Conclusion

- The dependence of active humus on the indicator of the intensive direction of soil formation procedures about soil zonality in the form of models (1) - (3) was found.
- Models obtained reflect deep-seated processes related to the photosynthetic activity of the Sun presented by Chizhevsky A.L. through polynomials of high degrees [15]. It is likely that processes of soil formation are wave-like and even degree polynomials are obtained by decomposing the cosine function in a series, and odd ones by the sine function. Therefore, laws presented in this paper, depending on the genesis of the soil, carry a conscious photograph at a certain time interval with a wave-like behavior dynamics, depending on solar activity, in addition to anthropogenic factors affecting water and soil objects of the research [6-8].
- Interconnected nonlinear models of colloidal active humus are a complex function determined by the genesis of the soil through the intensity and direction index of the soil formation process.
- The resource potential of colloidal active humus is not unlimited and therefore should be treated with care as with all the living nature that surrounds us.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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