Empirical Relationships of Humus Formation in Soils in the Arid Zone of Kazakhstan

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Abstract: ***It was performed analytical work to determine the relationship between the level of humification of the soil for the rational use of agronomic practices and predicting the biological yields of crops. Since there was a place of irrational use of bioenergy potential of the irrigated areas, the further formation and decomposition of the process of humus formation depends on the level of agricultural engineering and farming system. Rational use and introduction of innovative technologies like drip irrigation, automation, water management creates favorable conditions for expanded reproduction of soil fertility and environmental improvement in irrigated agriculture.***

Keywords: Humus formation, radiation index, fertility, terrain height, temperature and humidity

1. Introduction

The European Union, together with Kazakhstan, is implementing a project on tran-sition to a green economy model. Based on this project, in the address of the head of state to the people of the Republic of Kazakhstan from January 31 in 2017 "The third modernization of Kazakhstan: global competitiveness" noted that the agricultural sector should be a new driver of economy. This means about the needs to effectively use land for 5 years to increase the area of irrigated land by 40% to reach 2 million hectares with an increase in investment to agrarian research. While the implementation of priority directions by diversifying agricultural products in the agricultural sector allows increasing the level of processing products with the creation of an efficient system of storage, transportation and sales of goods, to ensure an increase in exports of food productsby 40% by 2021 [1]

The level of humus formation in natural conditions depends on agriculture from surface air tempe-rature, temperature and soil humidity, as well as from the evapotranspiration of the plant and evaporation with soil surface that have a direct effect on crop productivity. This allowsrational use of climate data and zonal distribution of crops in order to obtain maximum possible biological yield of irrigated farming.

Analysis of years of marketing research has shown that irrational use of energy resources led to strengthening processes of anthropogenic desertification, which causes the need to move to a new level of evaluation of the basic principles and farming system methods.

The practice of farming shows that the indicators of the ameliorativecomponents mode are far from equivalent in zone of the same geographical area. The optimal combination of land in the structure of the natural-ecological complex is a difficult task and its solution should be based on a quantitative description of the interrelated natural, anthropogenic impacts and be optimized with taking into account socio-economical and environmental indicators.

2. Literature Survey

It is known that water and nutrients that determine the regulation of the main factors of plant life are in a state of uninterrupted circulation, and their direction is the same, but the speeds differ significantly. So for example, ash and chemical elements are involved in both as biological and as man-made cycle, does the significant impact on the molecular processes occurring in the soil. Considering that soils are a complex mechanism, where microbiological processes play a significant role along with chemical reac-tions, agricultural production management should be aimed at regulating internal moisture circulation, balancing the accumulation and mineralization of organic matter and leading to an increase in fertility while satisfying the needs of plants in water and batteries [2,3].

The productivity of the agro-landscape, including the productivity of agricultural land and reclaimed land is assessed as follows. Equation 1.

$$P = S * CL \text{ (for natural cenosis) and}$$
$$P = S * ART * GGT \qquad (1)$$

where P = potential productivity of vegetation biomass in given soil and climatic conditions. t / ha of air-dry matter; S = index of the soil; CL - climate favorable factor; ART= indicator of compliance with the climatic conditions of this culture; GGT = coefficient depending on the culture of production.

With increasing production potential, it is very important to know the dynamics of accumulation or drawdown of humus reserves in the soil. The change in humus reserves can be approximately described by a differential equation 2 [4].

$$dG / dt = A - BG. \text{ t / (ha * year)} \qquad (2)$$

Integrating it gives:

$$G = A / B + (G_0 - A / B) \exp(-B * t)$$

where G_0 is the current reserves of humus, t / ha; A = formation of new humus due to humification of plant residues (G_{plant}) or organic fertilizers (G_{org}), including siderite, as well as loss of humus at descending moisture currents (G_{physis}), t / ha; B = coefficient taking into account the loss of humus, year $^{-1}$; t = time, year.

The formation of new humus is estimated by dependency, as shown in the equation 3.

$$A = Gplant + Gorg + Gphys \quad (3)$$

To calculate the amount of humus in the humification of organic residues, you can use the formula 4 [5]:

$$G = P * K_r * K_h\ , \quad (4)$$

where P is the yield of agricultural crops, t / ha; K * is the root yield ratio (dry matter); K_h - coefficient humification dry matter. The values of the coefficients K_r, and K_h are listed in table 1.

Estimation of the amount of humus coming in the composition of organic fertilizers is carried out using an iso humus coefficient determining the amount of stable humus formed from 1 kg (in terms of dry matter) of organic matter introduced into the soil or organic fertilizer, equation 5 [6]:

$$G_{org} = K_i \quad (5)$$

where K_i is the isohumus coefficient; D = dose of organic fertilizer, t / ha of dry matter.

From the analysis of these materials, it becomes clear that under the influence of vegetation, the number and composition of microorganisms, and consequently, the intensity of the processes in which they participate, change. Such changes, the result of the interaction of plants and microorganisms, deter-mine the degree of development and nutrition of crops. In this regard, it is believed that there is a need to study the microflora of the rhizosphere in order to develop techniques that favorably affect its deve-lopment and composition, improving the nourishment of oasthenia and obtain high yields, taking into account the energy resources of a particular area.

Based on many years of field research for the period 1984–2016 in the region of the southern Aral Sea region, N. Khozhanov [7-11] identified the structure of the formation of the natural environment, the level of soil humus formation (Mp), which shows that the maximum number of factors affecting the soil-forming process, focused on the level of the landscape provinces and geographical areas, is described by the following expression., equation (6).

$$M_p = (0.42\ R_h + 0.15\beta + 0.09S_n + 0.09T_b + 0.08W_B + 0.04V_B + 0.04O_C + 0.03\ M_{org} + 0.03_h) * 0.1\mu \quad (6)$$

where R_h "is the radiation balance taking into account terrain marks, β is the proportion of groundwater salinity, S_n is the indicator of soil salinity, T_b is the air temperature in ^{0}C,

Table 1: The value of the coefficients K_r and K_h [5]

Culture	Organic matter yield of root residues (dry matter) (K_r.)	Coefficient of humification of dry matter (K_h)
1-year perennial grasses for ha/y	0.6	0.2
1-year perennial grasses for há/y	0.15	0.2
Perennial grasses 2 and 3 years for há/y	1.2	0.2
Perennial grasses 2 and 3 years for green fodder	0.3	0.2
Annual herbs in ha/y	0.4	0.2
Annual herbs for green food	0.4	0.2
Cereals and legumes	0.8	0.2
Potatoes (roots)	0.1	0.1
Corn for silage	0.07	0.2

W_b is the air humidity in %, V_w, is wind speed, m/s, O_c is the amount of precipitation, mm/year, M_i is the fraction of salinity of irrigation water , h_h - level of ground water, g/l, μ - coefficient taking into account the use of agricultural methods and farming system [7-9].

In the process of humus formation, solar radiation (R), latitude ($_\varphi$) and altitude (H), as well as air temperature in period above 10 ° C [2, 3].

Empirical relationship of the radiation balance (R) with the sum of temperatures (t) above 10 °C:

- For areas of excessive moisture gives in the following formula (equation below as (6).

R = 8.52 + 0.01042 (∑ti)/n)> 10^{0}C (6)

- For the Urals:

R = 7.0 + 0.011(∑ti/n) > 10^{0}C (6)

- For Belarus:

R = 10.80 + 0.0093 (∑ti/n)> 10 ° C (6)

For the arid zone of Russia and Central Asia:

R = 13.39 + 0,0079 (∑ti/n)> 10 ° C

3. Methodology

In the sequence, the method of mathematical analysys, used the existing empirical formulas, and the basis of these it was identified empirial relationships between the ratio balance and the absolute elevation of terrain

4. Results and Discussions

For the natural system of Kazakhstan, the indicators of radiation balance(R), depending on the absolute height of the terrain (H), have not been previously considered. Therefore, we tried to identify this gap of science and clarify the actual energy indicators, taking into account the geography of the area:

- for the Southern region of Kazakhstan

$$R = LOc*(1000-H)/250 \qquad (7)$$

where L = heat of vaporization (cal/cm^2) Oc = Rain/Water precipation, mm/year. H = height of the terrain, m

In this proposed equations it is represented the actual geographical state of a paricular region. It clearly expressed indices of latent heat of vaporization (L), height of the terrain (H) and amount of precipitation (mm), which reliably reflects the actual values of the radiation balance (R) [4, 5, 12-14].

The study of the heat balance of the irrigated zone at allowed us to establish a link between the radia-tion balance (R) and evaporation (E_0), which is correlated by the dependence. Equation 8.

$$R = (E_o + 800) / (10*H) \qquad (8)$$

Thus, based on the data of the radiation balance, it becames necessary to further improve the metho-dology for regulating soil-meliorative criteria based on the energy resources of a specific area . The ratio of the radiation balance to the absolute height of the terrain in the arid zone of Central Asia and Kazakh-stan is about 0.61-28.96 and can be expressed in the form, shown in the equation 9.

$$R_H = R/H \qquad (9)$$

and describe as an indicator of the radiation index per unit of absolute height of the maximum. From here it can be seen that with the same soil and clima in the region, the indicators (R_H) are not the same. This gives grounds to believe that the agro technical and ameliorative measures used in the long-term section, aimed at obtaining large yields of agricultural crops, have not fully justified themselves. Since here was a place of irrational use of bioenergy potential, which determined insolvency and difference in terms of the indicator R_H) [8-12].

- For the mountainous zone $2.0 < R_H < 28.96$;

- For the foothill zone, the indicators range from $0.3 < R_H < 2.0$;

- For the flat zone of Kazakhstan - $0 < R_H < 0.3$

On the basis of the calculated climate data, it follows that a minimum values for the soil humus formation level is M_p= 0.852 %, and at maximum values it corresponds to 2.977%. The soil humus formation level changes depending on the absolute terrain presented in the equation 6.

Thus, over the course of many years in the development of the programmed cultivation of crops on the basis of predictive calculations using empirical formulas, scientists and experts distorted the calculated data to predict the food program, which ultimately affected the brutto yield and sustainability of the agricultural sector. Table 2 shows the results obtained by this paper.

Table 2: Calculation of the utilization rate of plant bioenergy resources

#	Meteo stations	Calculated bioenergy	Biological crop of corn for silo, t / ha		Opportunities for
		Coeficient (9)	when R based on (6)	with calculated R (7)	biological damage, share
1	Suzak	0.061	63.2	104.4	1.65
2	Turkestan	0.090	69.1	155.1	2.24
3	Tulkubas	0.096	63.8	164.5	2.57
4	Arys	0.091	69.9	172.2	2.35
5	Shymkent	0.127	65.9	217.5	3.5
6	Shardara	0.095	69.7	162.6	2.24

Since there was a place of irrational use of bioenergy potential of the irrigated areas, the further formation and decomposition of the process of humus formation depends on the level of agricultural engineering and farming system.

5. Conclusions

1. Implementation of the analytical work allows to determine the relationship between natural indicators and the level of soil humus formation (M_p) for the rational use of agricultural practices and prediction of biological yields of agricultural crops.
2. The proposed methods for calculating humus formation take into account the natural resources reflecting the influence of climate parameters for each region.
3. Studies have established that in the limits of the arid zone of Central Asia and Kazakhstan, in particular in the areas of the Southern Aral Sea region, natural climaec indicators provide an annual and natural/conditions to form from 0.852 to 2.977% of humus

4. In the plain zone, where the radiation index of the absolute height of the terrain (R_H) is 0.3 in order to maintain the process of humus formation at the level of 1-2% and more, it is necessary to intensify the level of agricultural budgets through the widespread introduction of phyto- melioretive crops.
5. Rational use and introduction of innovative technology, such as drip irrigation, water use automation, creates favorable conditions for the soil fertility and ecological improvement of irrigated agriculture.

6. Future Scope

It is expectedto improve land use approaches of the regional use of land taking into account the radiation in balance in a specific geograpthical area, like Kazakhstan and in Brazil.

Acknowledgments

The authors would like to acknowledge Mr. Angsar for his helpful aid, Taraz State University and Federal University of Ouro Preto to provide conditions for publishing this paper.

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