ПЛОДОРОДИЕ ПОЧВ

УДК 631.41

M.A. Ibrayeva[1], M. Polatova[1], A. Otarov[1, 2]

DEVELOPMENT OF BASES OF ORGANIC FARMING FOR RICE CROP ROTATIONS IN AKDALA IRRIGATION AREA IN SOUTHEASTERN KAZAKHSTAN

[1]Kazakh Research Institute of Soil Science and Agrochemistry after U.U. Uspanov, 050060, Almaty, 75 V al-Farabi avenue, Kazakhstan, e-mail: ibraevamar@mail.ru

[2]Research Center for Ecology and the Environment of Central Asia (Almaty), 050060, Al-Farabi avenue 75, Almaty, Kazakhstan

Abstract. The article presents the study results of the bio-meliorants effects on biological activity, humus status in rice-marsh soils, and rice yield. It was found that the use of bio-ameliorants Green-Eco, Edagum and sodium humate effectively influence on biological activity of the soil. The research results showed that the most optimal bio-meliorant for positive balance of humus and improvement of its quality is Green-Eco at a minimum dose of 50 kg/ha. Edagum with the introduction of 100 and 150 l/ha increased the total content of humus, although it slightly reduced its quality.

Key words: organic farming, humus , fertility of periodically flooded rice soils.

INTRODUCTION

Technical progress brings to humans not only material wealth, but also causes ever-increasing technogenic impacts on biosphere - soil, water reservoirs, rivers, atmosphere, living organisms. Factors that cause it include the use of chemicals in agriculture. High doses of mineral fertilizers, numerous processing plant protection chemicals, violation of application technologies, intensive soil tillage, deep plowing result in a whole range of negative environmental impacts. Chemization brakes self-regulation in live nature weakens protection forces of plants, animals and humans. Old, experienced agricultural technologies are no longer able to cope with these problems. Mankind faces a problem of further development of land cultivation, search for alternative ways to maintain its high performance and environmental safety. Biotechnology should replace the old technology, and at present stage only it can help to solve environmental, energy and food problems of the humanity. One of such areas is the development of organic farming. Importance of organic farming in national aspect can be confirmed by the words of the President. According to the President of the Republic of Kazakhstan Nursultan Nazarbayev" we are already one of the largest exporters of grain. We have a huge eco-friendly areas and can produce environmentally friendly food products. We are able to make a qualitative leap in agricultural production. For this we will need a new type of public thinking "[1]. Importance at international level - is Kazakhstan's accession to the WTO, which means special attention to the quality of products. And the introduction of organic farming will give farmers the opportunity to receive high-quality environmentally friendly agricultural products.

OBJECTS AND METHODS

The object of study is the Akdala irrigation array, which is located on the ancient Akdala-Bakanas delta, which occupies most of the area of the lower Ili River. The Akdala delta is the most ancient and in geomorphological terms is a wavy alluvial plain with a slight slope of the surface to the north-west, insignificant altitudes above sea level, not exceeding on average 390-413 m, the presence of eolian relief forms in the form of hilly ridge and hilly sands, which stand out against the general background. The geological structure of the Akdala irrigation array is represented by a complex of loose alluvial deposits, mainly of light granulometric composition below and Middle Quaternary age up to

100-260 m, which by hydrogeological conditions are a hydrodynamic single aquiferous complex. According to the long-term data of the Almaty hydrometeorological observatory [2], the massif under consideration belongs to the northern desert agroclimatic region. The hottest month is July with an average monthly air temperature of + 25,4°C, and the coldest is January with a temperature of - 13,2°C. The average annual amount of precipitation does not exceed 130-150 mm. Their greatest number falls on the cold period of the year. The duration of the period with a steady snow cover is 80-95 days, the maximum average decade of snow cover is 10-15 cm, and water reserves in the snow are 25-35 mm. Farming in this zone is possible only with irrigation. The main source of irrigation is the Ili River with tributaries Charyn, Chilik, Kurty, Talgar, Kaskelen. The main land fund of the array is represented by takyr-like soils, which make up 73 % of its total area. The formation of these soils is due to the processes of desertification of hydromorphic soils (alluvial-meadow, marsh-meadow, meadow-marsh, etc.), developed in accordance with the law of litho-morpho-pedogenesis on variegated layered alluvial deposits of different lithological composition.

This work has been done based on the following main methods of soil research: stationary methods, techniques of field pot experiments, the method of soil-regime observations, method of soil extracts.

RESULTS AND DISCUSSION

Specificity of humification and mineralization of soil organic matter and the rate of mineralization of the litter and other organic matters entering the soil determines the biological activity of soil. As points Berestetskiy O.A. et al [3] the rate of transformation of various compounds, the decomposition of plant residues, the accumulation of plant nutrients and, ultimately, soil fertility depend on the activity and orientation of biological processes in soil. Therefore, we also studied the effect of application of biomeliorants into low-yielding rice soils on its biological activity. Protease activity and intensity of accumulation of amino acids have been investigated. Below are the details of the variation-statistical processing of data on the effect of different doses of drugs "Green Eco", "Edagum" and "Sodium humate" on protease activity of the soil. Reliability of the obtained secondary data was evaluated by Student t-criteria. Analysis of obtained actual values of Student t-criteria shows that statistical validity (tact. > ttab.) % of dilution of gelatin layer of photo paper exposed in soil on experiment options (Table 1).

Table 1 – Effect of different doses of drugs "Green Eco", "Edagum", “Sodium humate” and soil protease activity, % of dilution of gelatin layer of photo paper (application method)

Options	M±m	Fluctuation range	t-criteria		± $t_{0,05}$ * m	V,%
			$t_{act.}$	$t_{0,05}$		
Control	49,9±1,85	46,8÷53,2	26,9	3,2	7,9	6,4
Green-Eco 50 kg/ha	98,4±0,23	98,0÷98,8	42,0	3,2	1,0	0,4
Green-Eco 100 kg/ha	98,1±0,13	98,0÷98,4	73,0	3,2	0,6	0,2
Green-Eco 150 kg/ha	96,8±0,23	96,4÷97,2	41,0	3,2	1,0	0,4
Edagum 50 l/ha	97,2±0,23	96,8÷97,6	42,0	3,2	1,0	0,4
Edagum 100 l/ha	86,9±1,31	84,4÷88,8	66,0	3,2	5,7	2,6
Edagum 150 l/ha	77,6±1,60	74,4÷79,2	49,0	3,2	6,9	3,6
Gumat Na 50 kg/ha	95,6±0,46	94,8÷96,4	20,0	3,2	2,0	0,8
Gumat Na 100 kg/ha	98,9±0,27	98,4÷99,2	37,0	3,2	1,1	0,5
Gumat Na 150 kg/ha	97,2±0,46	96,4÷98,0	21,0	3,2	2,0	0,8

Analysis of the degree of variability on experiment options also shows that the average mean values are statistically stable. The values of their variation coefficients serve as confirmation of this fact, which do not exceed 6.4 % in the control, and 0.4 % in the option with "Green Eco", 3.6 % in the option with" Edagum" and 0.8 % in the option with "Sodium humate" and on the gradation scale insignificantly correspond to the limit.

The fluctuation range of absolute values % of dilution of gelatin layer of photo paper, exposed in the soil on laboratory experiment option is also quite narrow, that also, although indirectly, points to statistical reliability of obtained average values of experiment options. So, we can say that the obtained average mean values % of dilution of gelatin layer of photo paper in soil on experiment options are statistically reliable and can be used to summarize the results obtained on the study of the effect of biomeliorants on protease activity of periodically flooded rice soils of laboratory experiment. The conducted analysis of average statistical data of proteolytic activity in soils on laboratory experiments options showed that among the tested biological meliorants most optimal variant was introduction of application of "Green-Eco" at a dose of 50 kg/ha, in which there is maximum % of dilution of gelatin layer which is equal to 98,4 % ± 0.23. Almost the same effect had application of Edaguma and Sodium humate, but in these options to achieve same effect was needed the application of twice higher dose than dose of Green-Eco. The analysis of average values of protease activity shows that all tested biomeliorants have significant effect compared with the control (Figure 1). Increasing of the percentage of emulsion dilution in various options ranges from 27.7 to 49.0 percent. As the figure 1 shows the proteolytic activity is twice higher than in control in application of 1 dose of all used biomeliorants.

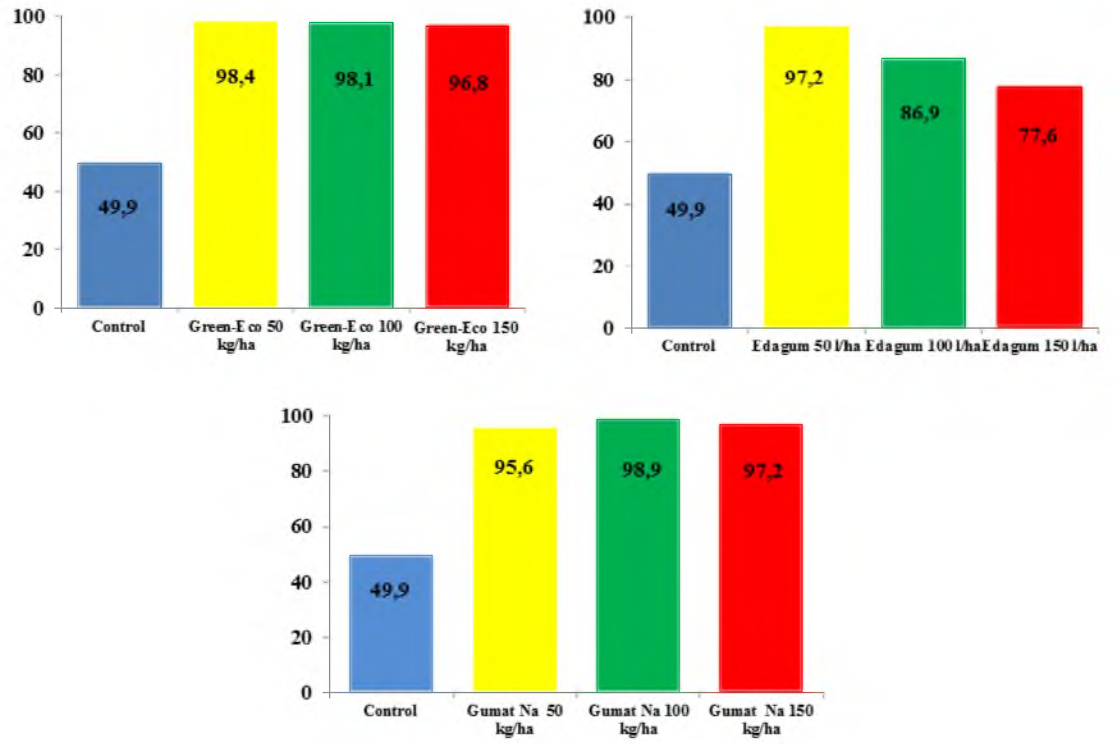

Figure 1 – Impact tested for proteolytic activivty biomeliorants

Cellulose activity of soil was determined by method of "applications" on decomposition of linen tissue in it. But since the degree of activity of cellulose microorganisms depends on the presence in soil of available nitrogen, phosphorus and other elements, the degree of decomposition , can be considered to reflect "the tension of microbiological processes in general" [4]. Variation- statistical processing of obtained average data showed their statistical reliability, which was assessed by the Student t-criteria (Table 2). At 0.95 % of probability of actual values of Student's t-criteria in all experiment options are higher than their table value that indicates their statistical reliability.

Table 2 – Effect of different doses of "Green Eco" on the intensity of accumulation of amino acid in the experiment variants

Options	M±m	Fluctuation range	t-criteria		$\pm t_{0,05} * m$	V, %
			$t_{fact.}$	$t_{0,05}$		
Control	37,6±0,46	36,8÷38,4	81,4	3,2	2,0	2,1
Green-Eco 50 kg/ha	98,5±0,35	98,0÷99,2	27,0	3,2	1,5	0,6
Green-Eco 100 kg/ha	96,1±0,48	95,2÷96,8	20,0	3,2	2,1	0,9
Green-Eco 150 kg/ha	92,7±0,48	92,0÷93,6	19,0	3,2	2,1	0,9
Edagum 50 l/ha	99,2±0,23	98,8÷99,6	43,0	3,2	1,0	0,4
Edagum 100 l/ha	86,0±0,92	84,4÷87,6	9,3	3,2	4,0	1,9
Edagum 150 l/ha	78,3±0,93	76,4÷79,2	84,0	3,2	4,0	2,1
Gumat Na 50 kg/ha	98,7±0,35	98,0÷99,2	28,0	3,2	1,5	0,6
Gumat Na 100 kg/ha	96,4±0,46	95,6÷97,2	20,9	3,2	2,0	0,8
Gumat Na 150 kg/ha	96,5±0,35	96,0÷97,2	27,4	3,2	1,5	0,6

The analysis of the degree of variability of the experiment variants in which values of their variation coefficients range within 0,4-2,1 % according to grade scale slightly correspond to the limit value and indicates statistical stability. Limits of variation of particular average values and limits of confidence interval are quite narrow, which, although indirectly, indicates statistical stability of the obtained average values of the experiment variants. Thus, we can say that obtained average values % of intensity of destruction of linen fabrics in soils on laboratory experiment options are statistically reliable and can be used to summarize the results obtained on research of the effect of biomeliorants on the intensity of amino acids accumulation. The conducted analysis of average statistical data on intensity of amino acids accumulation in soils on experiment variants also showed that all tested biomeliorants have significant effect compared to the control. Increase of the percentage of decomposition of linen in various variants, as compared with the control range within 40,7-61,6 percent. The maximum effect is also obtained from the lowest doses of tested biological meliorants, in which the percentage of decomposition of linen reaches 98.5-99.2 % (Figure 2).

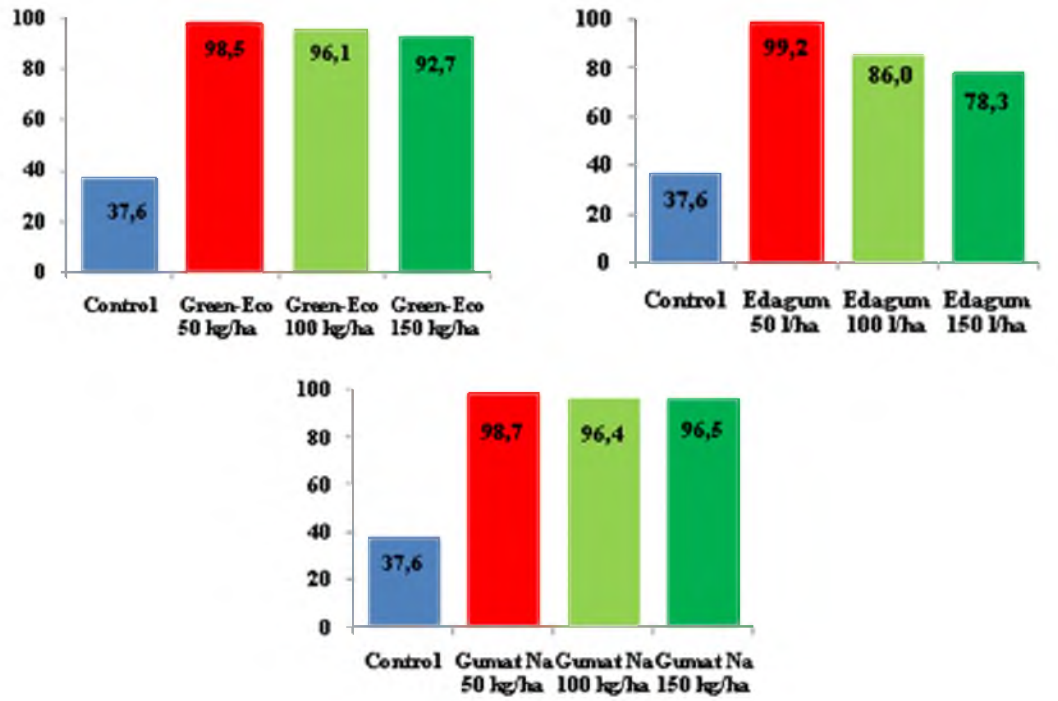

Figure 2 – Influence on the intensity of the tested biomeliorants accumulation of amino acids

It is well known that soil humus is a major source of nitrogen and other plant nutrients. In accumulation of humus occurs the biological accumulation of these elements in soil, and during its decomposition, they gradually release in form of mineral compounds absorbed by plants. Crop production, leaving many crop residues in soil (alfalfa, etc.), and application of bioorganic fertilizers contribute to the accumulation of humus in soil. We investigated the effect of different doses of application of "Green- Eco", "Edagum" and "Sodium humate" on indicators of humus condition of low productive rice- swamp soils. The results obtained show that the tested doses of biomeliorants have statistically reliable positive effect on total humus concentration (Table 3). Data on humus balance are proving this fact. In all variants of the experiment a positive balance is observed. The biggest increase in total humus concentration is observed in option with application of Green-Eco 50 kg/ha. Positive balance was +10.7 %, whereas twice increase of its dose has reduced humus content to 10.7 %, and increase three times to 7.1 %. That is, the positive effect of biomeliorants Green-Eco is observed only in application of small doses that is important for the farmers from the economic point of view. Opposite effect on the total humus content in soil was observed in application of different doses of Edagum. So, the application of 50 l/ha of this biomeliorant had no impact on the total humus content, and it was the same as in the control variant. Humus content increased by 7.1 % in application of 100 l/ha and by 10.7 % in application of 150 l/ha of Edagum. Application of sodium humate in the amount of 50, 100 and 150 kg/ha had a negative impact on total humus content. Their content decreased respectively by 10.7 %, 3.6 % and 10.7 %. Evaluation of average values of all indicators of soil humus status of investigated soils using Student t-criteria shows their statistical reliability, actually in all studied options $t_{fact.}$ is higher than $t_{tabl.}$ Variation of total humus content and other indicators are low, and insignificant and average within grade limits.

Table 3 – Effect of application of different doses of biomeliorants on soil humus status indicators of the laboratory experiment a month after flooding

Showing	M±m	Fluctua-tion range	t-criteria		± $t_{0,05}$ * m	V,%	Humus balans, ± %
			$t_{fact.}$	$t_{0,05}$			
1	2	3	4	5	6	7	8
Control							
Total humus, %	2,8±0,2	2,5÷3,3	11,5	3,18	1,06	8,7	
C:N	10,8±1,5	9,3÷13,8	7,4	3,18	6,32	13,6	
N in the humus content,%	5,5±0,7	4,2÷6,3	8,4	3,18	2,85	12,0	
Green-Эко, 50 kg/ha							
Total humus, %	3,1±0,2	2,7÷3,3	15,3	3,18	0,87	11,3	+ 10,7
C:N	11,6±1,5	8,6÷13,8	7,4	3,18	6,72	23,3	
N in the humus content,%	5,2±0,7	4,2÷6,7	6,7	3,18	3,34	26,0	
Green-Эко, 100 kg/ha							
Total humus, %	2,5±0,04	2,5÷2,6	63,7	3,18	0,17	2,7	- 10,7
C:N	8,7±0,54	7,9÷9,7	16,2	3,18	2,31	10,7	
N in the humus content,%	6,7±0,4	6,0÷7,3	16,8	3,18	1,73	10,3	
Green-Эко, 150 kg/ha							
Total humus, %	2,6±0,06	2,5÷2,7	46,7	3,18	0,24	3,7	- 7,1
C:N	8,8±0,5	7,7÷9,4	16,5	3,18	2,29	10,5	
N in the humus content,%	6,7±0,4	6,2÷7,5	15,5	3,18	1,84	11,1	8
Edagum 50 l/ha							
Total humus, %	2,8±0,04	2,7÷2,8	70,1	3,18	0,17	2,5	0
C:N	9,3±0,19	9,0÷9,6	49,9	3,18	0,80	3,5	
N in the humus content,%	6,3±0,13	6,0÷6,5	50,0	3,18	0,54	3,5	
Edagum 100 l/ha							
Total yumus, %	3,0±0,19	2,7÷3,3	15,5	3,18	0,82	11,2	+ 7,1
C:N	10,1±1,25	8,4÷12,5	8,1	3,18	5,36	21,4	
N in the humus content,%	5,9±0,67	4,6÷6,9	8,8	3,18	2,89	19,6	
Edagum 150 l/ha							
Total humus, %	3,1±0,05	3,1÷3,2	60,6	3,18	0,22	2,9	+ 10,7
C:N	9,5±0,21	9,1÷9,8	44,4	3,18	0,92	3,9	
N in the humus content,%	6,1±0,14	5,9÷6,4	43,8	3,18	0,60	4,0	
Gumat Na 50 kg/ha							
Total humus, %	2,5±0,03	2,5÷2,6	84,2	3,18	0,13	2,1	- 10,7
C:N	7,6±0,38	6,9÷8,1	19,8	3,18	1,65	8,8	
N in the humus content,%	7,7±0,40	7,1÷8,5	19,0	3,18	1,74	9,1	

Continuation of table 3

Gumat Na 100 kg/ha							
Total humus, %	2,7±0,1	2,5÷2,8	27,3	3,18	0,42	6,3	- 3,6
C:N	7,9±0,61	6,9÷9,0	13,0	3,18	2,62	13,3	
N in the humus content,%	7,4±0,58	6,5÷8,5	12,7	3,18	2,50	13,6	
Gumat Na 150 kg/ha							
Total humus, %	2,5±0,01	2,48÷2,51	28,2,7	3,18	0,04	0,6	- 10,7
C:N	6,9±0,24	6,5÷7,3	28,4	3,18	1,04	6,1	
N in the humus content,%	8,4±0,29	7,9÷8,9	28,6	3,18	1,27	6,1	

The most important characteristic of easy degradable organic matter is its content of nitrogen, and the ratio of C:N, which affects the rate of decomposition of labile organic matter. As known, the main part of soil nitrogen comes precisely from the easy degradable organic matter. The ratio C:N in the soil is an indicator of humus which is relatively rich in nitrogen. Narrow correlation C:N in gray soil is probably the result of high population of soil microorganisms that facilitates enrichment of soil humus in microbial protein [5]. In our experience, as can be seen from the table, different doses of biomeliorants have different impact on these indicators. Thus, nitrogen content of humus in application of Green-Eco at 50 kg/ha has decreased compared with the control (5.5 %) to 5.2 %, i.e. humus became richer in carbon that is good for effective soil fertility. In increasing doses of biomeliorants to 100 and 150 kg/ha nitrogen concentration in humus has increased to 6.7 % in both cases. C:N ratio in application of 50 kg/ha of Green-Eco was equal to 11.6 versus 10.8 in the control variant, i.e. humus has become more saturated with carbon, and in other two variants with high doses (100 and 150 kg/ha) this indicator was lower than in the control, 8.7 and 8.8 respectively. There is obvious negative impact on the quality of humus, although in general the total humus content has increased. Thus, application of a smaller dose of Green-Eco (50 kg/ha) had a positive effect on total content of humus and its quality. Application of different doses of Edagum into studied soils also had different impact on nitrogen content of humus and ratio C:N (Table 3), although exact opposite than Green-Eco. So, nitrogen content in humus in all experiment options increased compared to control (5.5 %): in application of 50 l/ha to 6.3 %, 100 l/ha to 5.9 %, and 150 l/ha to 6,1 %, i.e. humus became more saturated with nitrogen than carbon. Naturally, the ratio C:N also changed, it became narrower and was 9.3, 10.1 and 9.5, respectively, whereas in the control it was 10.8. Sodium humate also had different effect on the studied parameters of humus status. Nitrogen content in humus had significantly increased and was 7.7 % at a dose of 50 kg/h, 7.4 % at application of 100 kg/ha and 8.4 % at 150 kg/ha, whereas in the control this indicator was equal to 5.5 %. In soil humus of these variants the proportion of nitrogen has increased. Naturally the ratio of carbon to nitrogen has also decreased. C:N ratio decreased to values of 7.6, 7.9 and 6.9 respectively to experiment variants.

CONCLUSION

Thus, application of these biomeliorants into soil had effective impact on soil biological activity. Most optimal biomeliorant which has a positive effect on total humus content and its quality indicators is Green-Eco at dose 50 kg/ha. However Edagum in application 100 and 150 l/ha has also increased total humus content, although slightly reduced its quality. But sodium humate had negative impact on total humus content.

REFERENCES

1 N.A. Nazarbayev Message of the President of the Republic of Kazakhstan - the leader of the nation to the people of Kazakhstan 2012. Strategy "Kazakhstan-2050".

2 Agroclimatic resources of the Almaty region of Kazakh SSR. – L., Gidrometeoizdat, 1978. – 200 p.

3 O.A. Berestetskiy, Y.M. Voznyakovskaya, L.M. Dorosinsky. Biological basis of soil fertility. – M.: Publishing house "Kolos", 1984. – P. 218.

4 E.N. Mishustin, I.S. Vostrov, A.N. Petrova. Definition of soil biological activity by different methods, Microbiology. – 1961. – V. 30. 4. – P. 665-672.

5 M.M. Kononova. Soil organic matter. – M.: Publ. Nauka, 1963. – 314 p.

ТҮЙІН

М.А. Ибраева[1], М. Полатова[1], А. Отаров[1, 2]

ҚАЗАҚСТАННЫҢ ОҢТҮСТІК-ШЫҒЫСЫНЫҢ АҚДАЛА СУАРМАЛЫ АЛҚАБЫНДА КҮРІШ ДАҚЫЛЫН ӨСІРУ ҮШІН ОРГАНИКАЛЫҚ ЕГІНШІЛІК НЕГІЗДЕРІН ӘЗІРЛЕУ

[1]Ө.О. Оспанов атындағы Қазақ топырақтану және агрохимия ғылыми-зерттеу институты, 050060, Алматы қ., әл-Фараби даңғылы, 75В, Қазақстан, e-mail: ibraevamar@mail.ru

[2]Орталық Азия экология және қоршаған орта ғылыми-зерттеу орталығы (Алматы), 050060, Алматы қ. әл-Фараби даңғылы, 75В, Қазақстан

Мақалада күріш топырақтарының биологиялық белсенділігіне, гумустық жағдайына және күріштің өнімділігіне биомелиоранттардың әсерін зерттеу нәтижелері кертілінген. Green-Eco, Эдагум және натрий гуматы сияқты биомелиоранттарды қолдану топырақтардың биологиялық белсенділігіне оң әсер ететіндігі анықталды. Зерттеу нәтижелері гумустың оң балансын қалыптастыруда және оның сапалық көрсеткіштерін жақсартуда оптималды биомелиорант дозасы 50 кг/га Green-Eco екендігін көрсетті. Бірақ Эдагум да 100 және 150 л/га дозасын қолданғанда жалпы гумустың мөлшерін арттырды, дегенмен оның шамасын біршама төмендетті.

Түйінді сөздер: органикалық шаруашылық, гумус, араға уақыт салып суарылатын күріш топырақтарының құнарлылығы.

РЕЗЮМЕ

М.А. Ибраева[1], М. Полатова[1], А. Отаров[1, 2]

РАЗРАБОТКА ОСНОВ ОРГАНИЧЕСКОГО ЗЕМЛЕДЕЛИЯ ДЛЯ ВЫРАЩИВАНИЯ КУЛЬТУРЫ РИСА В АКДАЛИНСКОМ МАССИВЕ ОРОШЕНИЯ ЮГО-ВОСТОКА КАЗАХСТАНА

[1]Казахский научно-исследовательский институт почвоведения и агрохимии им У.У.Успанова, 050060, г. Алматы, пр. Аль-Фараби, 75 В, Казахстан, e-mail: ibraevamar@mail.ru

[2]Научно-исследовательский центр экологии и окружающей среды ЦА (Алматы), 050060, г. Алматы, пр. Аль-Фараби, 75 В, Казахстан

В статье приводятся результаты исследования влияния биомелиорантов на биологическую активность, состояние гумуса рисово-болотных почв и урожайность риса. Было установлено, что применение биомелиорантов Green-Eco, Эдагум и гумат натрия, эффективно влияет на биологическую активность почв. Результаты исследований показали, что наиболее оптимальным биомелиорантом в формировании положительного баланса гумуса и улучшения показателей его качества является Green-Eco в минимальной дозе 50 кг/га. Эдагум при внесении 100 и 150 л/га увеличил общее содержание гумуса, хотя и немного снизил его качество.

Ключевые слова: органическое земледелие, гумус, плодородие периодически затопляемых рисовых почв.