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РЕСПУБЛИКИ КАЗАХСТАН

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THE BIOLOGICAL EFFICIENCY OF CROP ROTATIONS AND GREEN MANURES TO IMPROVE THE PRODUCTIVITY OF IRRIGATED LANDS

Abstract. The results of studies on improving the basic conditions for the reproduction of soil fertility, increasing the productivity of irrigated lands and obtaining ecologically clean products in the system of biologized crop rotations are presented.

Key words: biologized crop rotations, green fertilizers, soil, humus, productivity agricultural crops.

The emergence of new concepts and requirements in the sustainable development of the world economy could not but affect such an important sector as agriculture, which directly depends on nature and causes no small environmental damage [1].

In the structure of world agricultural production today, there are obviously several directions that are the most promising for its development. One such area is organic farming.

Organic agriculture is a complex system of production management, oriented to improving the agroecosystem as a whole, as well as to maintain biodiversity, biological cycles and biological activity of the soil. Priority in it is given not to additives imported from outside, but to agrotechnical methods, taking into account the fact that local conditions require systems adapted to them. This is achieved by applying cultivation, biological and mechanical methods instead of using synthetic substances to implement any function within the system [2, 3].

The Republic of Kazakhstan has various natural and climatic, including soil and land resources. However, the scale of anthropogenic impact is such that a significant part of the land, including agricultural land (the total area of arable land is 26 million hectares), is in an unsatisfactory state due to various negative processes and phenomena [4].

The concept of the transition of the Republic of Kazakhstan to a "green economy" lays the foundations for profound systemic transformations with a view to shifting to the economy of a new formation by improving the welfare of the people, the quality of life of the population of Kazakhstan and entering the country among the 30 most developed countries of the world, and degradation of natural resources [5].

Agricultural production current stage of development, requires systematic and widespread increase in the fertility of Kazakhstan's irrigated lands.

The current environmental problems that have arisen as a result of anthropogenic overload and irrational use of natural resources have undoubtedly affected the state of the soil cover of the territory of Kazakhstan. The destabilization of the ecological situation has led to the degradation of the soil cover in all natural zones of the republic. As you know, Kazakhstan is one of the ten largest countries in the world with the largest area, and the population is on the 80th place in terms of population. Compiling 0.3 world population, Kazakhstan occupies 2% of the globe [6]. Territory of Kazakhstan according to aerospace survey and expert assessment, consist of medium-degraded soils are 35%, heavily-degraded soils - up to 15%. The solution of ecological problems of the soil cover of Kazakhstan now requires urgent measures. Moreover, both for the sake of the security of our state, and for preserving the healthy population of the

country as a whole. Already today, about 60% of the soil cover of the Republic of Kazakhstan refers to degraded to varying degrees, depending on the nature of the natural conditions and their economic use. Recently, according to scientists, in the republic there is a significant deterioration of soil-meliorative and soil-ecological status, intensive decline of soil fertility, development of water and wind erosion, and secondary salinization. As a result, the yields of agricultural crops in our country are noticeably behind the level of the countries that are with us in similar natural and climatic conditions. Therefore, the issues of improving the ecological situation in modern agro landscapes, maintaining and reproducing soil fertility and increasing crop productivity have become especially urgent at the present time. There was a need to create not only environmentally sustainable and safe technologies and techniques, but also the management of farming systems in general.

In this connection, we set ourselves the task of studying the influence of biologisation means and scientifically based selection of crops in the system of biologized crop rotations for the reproduction and conservation of soil fertility, increasing the productivity of irrigated lands and obtaining environmentally friendly products.

Research material and methods. The study of the effect of various biologic means and crops on the fertility and biochemical properties of light chestnut soils was carried out in the green manure link of the 8-field grass-grazing (winter wheat + alfalfa, alfalfa 2 years of life, alfalfa 3 years of life, winter wheat (used $N_{80}P_{50}K_{140}$; green manure -8.9 t / ha, manure-20 t / ha), sugar beet, soybeans, sugar beet, corn) and 3-hollow grain-crop rotations (winter wheat + siderates, sugar beet, soybeans).

In 8-field grassy-grained rotation, organic and mineral fertilizers were added to the sugar beets sown after winter wheat by the turnover of the alfalfa layer of 3 years of standing. In the experiment, variants were studied with the application of manure, the calculated dose of mineral fertilizers (by 500 centners / ha of root crops), as well as the sedimentation of the green manure (peas) of their action and aftereffect under the crops most productive use of the vegetative period for maximum accumulation of organic matter. The first control is a variant without applying fertilizers. The second option is the option of adding mineral fertilizers for sugar beet in doses calculated by the balance method. The principle of calculation of fertilizer doses was as follows: the average yield over a number of years of crop yields obtained with the application of recommended fertilizer doses, further increase in yield was determined by additional application of fertilizers.

In the 3-hollow grain-crop rotation after winter wheat, a vetch mixture (green manure) was grown, and then it's green plant mass, in an amount of 10 tons / ha, was plowed into the soil.

The activity of humic enzymes (polyphenol oxidase and peroxidase) was determined by the method of K.A. Mikhailovskaya and L.A. Karyaginoy on the photoelectric calorimeter (FEC). The humus content was determined by the method of I.V. Tyurin.

In the experiments, agricultural technology recommended for the irrigated zone of the southeast of Kazakhstan was used.

Research results and discussion. The activity of enzymes reflects the genetic features of soil processes. One of the sources of enzymes are soil microorganisms. With a significant level of metabolism, they release into the environment a large number of active enzymes. Enzymes are released from the cells of microorganisms during their autolysis and pass into the soil. High activity of enzymes indicates the vigorous activity of microflora and the activity of biological processes occurring in soils. Therefore, enzymatic activity can be considered as an important indicator of biological activity of soils and their productive capacity [7].

Humification of organic substances, which are basis of soil formation and soil fertility, is carried out by bacteria, fungi, actinomycetes and is accompanied by the manifestation of a high activity of phenoloxidases, in particular polyphenol oxidase, which favors polymerization reactions and the formation of polysaccharides, amino acids, polyphenols and other substances. Peroxidase activates the mineralization reaction, so that the soil is enriched with mineral substances necessary for the growth and development of plants. To characterize the dynamics of humus accumulation in soils, the ratio of polyphenol oxidase activity to peroxidase activity is used, expressed as a percentage and conventionally called the coefficient of humus accumulation. The data indicate that, on average, during vegetation, the activity of polyphenol oxidase in the soil of the control variant is 3.7 mg of benzoquinone in 30 minutes incubation, peroxidase - 4.8 mg. The coefficient of humus accumulation does not exceed 77%. When organic fertilizers are

introduced into the soil for sugar beets, the processes of transformation of humic substances are activated. The highest activity of polyphenol oxidase was observed in the soil of the variant, where green fertilizer was added-5.5 mg. In this variant, the process of mineralization of humus is the most vigorous - 5.7 mg. However, on average, during the vegetation the coefficient of humus accumulation is high - 96%.

The cultivation of soybeans after sugar beet contributes to the intensification of processes of polymerization and utilization of humic substances. According to the parameters of enzyme activity in the soil of the control variant, the polyphenol oxidase activity varies during the vegetation from 4.1 to 5.2 mg, peroxidase activity varies from 4.7 mg to 6.2 mg, and the humus accumulation coefficient ranges from 68 to 87%. A similar pattern has been established also in the soil of a variant of the aftereffect of mineral fertilizers. For two years, the positive effect of organic fertilizers on the processes of formation of humus components persists, especially in the variant where the green mass of peas was harrowed. The processes of mineralization of humus are reduced. The coefficient of humus accumulation during the soybean vegetation in the soil of these variants varies from 114% to 130% and from 92% to 113% (respectively aftereffects of mineral fertilizers and manure).

For the third year after the introduction of fertilizers, their effect on the accumulation of humus in the soil is reduced. The cultivation of sugar beet after soybeans, on average for vegetation according to options, provides the activity of polyphenol oxidase from 3.7 to 4.8 mg, peroxidase from 3.5 to 5.6 mg. The coefficient of humus accumulation is from 80 to 109%. It should be noted that only in the soil of the variant, where the aftereffect of manure was taken into account, and the intensity of the processes of humus transformation is much lower. The activity of polyphenol oxidase does not exceed 3.0-4.0 mg, peroxidase 3.4-3.6 mg, but the coefficient of humus accumulation is greatest. During the entire growing season, it varies from 86 to 117%.

In the 3-field crop rotation, the introduction of a large amount of plant residues of winter wheat into the soil and the easily hydrolyzed vico oatmeal mixture sharply activated the processes of humus formation and mineralization of organic matter. In autumn, the activity of polyphenol oxidase and peroxidase increases to 4.6-4.8 mg. Humus accumulation during the growing season was 98-111%.

Under sugar beet, the activity of polyphenol oxidase and peroxidase gradually increased from sowing to harvesting of root crops. However, in the soil of the control variant, the processes of mineralization of humus are more active. The activity of peroxidase exceeds the intensity of polymerization processes by 0.2 mg. The accumulation coefficient of humus is 89-90%.

Under the soybeans, which go after sugar beet, an intensive process of humus formation and a moderate process of its mineralization, especially in summer and autumn, are evidently connected with the active release of soybean exudates and the beginning of mineralization of nodules, litter and dead roots rich in nitrogen.

The highest activity of polyphenol oxidase (4.2 mg) was noted in the soil after the action of the green manure. The stock of legume-cereal grass mix for sugar beet for two years provides favorable conditions for accumulation of humus and stabilization of soil fertility in 3-grain grain-crop rotation.

Analysis of the values of the correlation coefficients shows that the activity of polyphenol oxidase and peroxidase positively correlates with the yield of sugar beet ($r = 0.73; 0.77$) only when cultivated without fertilization, which indicates intensive use of humus to create a crop.

In the case of applying mineral fertilizers and 20 tons of manure for sugar beet, a negative correlation was established between the activity of humic enzymes and the number of all physiological and taxonomic groups in the micropower population of the soil ($r = -0.66; 1.0$). In the soil of these options, the entire microbiocenosis involved in the transformation of plant and mineral compounds works to provide plants with basic nutrients.

When the green fertilizer is primed, the activity of polyphenol oxidase and peroxidase positively correlates ($r = 0.65; 0.99$) with the total biological activity of the soil. Consequently, the use of green manure contributes to an increase in the content of humus and the general level of soil fertility.

Reproduction of fertility of arable soils is one of the primary problems of modern agriculture. On irrigated lands in the south and southeast of Kazakhstan, this is accomplished through a three-year cultivation of alfalfa. The increase in humus content under perennial grasses is primarily due to the orientation in the soil of processes that ensure the restoration of the disturbed balance between the intake of organic matter and its decomposition. In the absence of intensive mechanical treatments on crops of

perennial grasses, the supply of organic matter to the soil prevails over its decomposition, which is determined by an increase in the activity of biochemical processes toward optimal modes of humus formation.

In our experiments, the state of soils under perennial grasses was close to the above conditions. So, in the spring period there was a combination of favorable moistening of the soil with temperature regimes, then in June there comes a period of moisture deficit, followed by July precipitation, followed by the August drought and all this is evident against the background of the compacted state of the soil. In the fields, multiple mechanical treatments, increasing soil aeration, intensified aerobic processes that destroy organic compounds involved in humus formation.

As our studies have shown, the dynamics of humus content in the soil in different years, and also during one growing season, varies continuously, depending on the complex of meteorological conditions and agro-practices that develop.

The initial content of humus before laying down the experience of 8-field crop rotation was 1.96%. After plowing 3-year-old alfalfa, the humus increased by 0.8-0.9%, that is, it amounted to 2.0%. When sowing winter wheat, which goes along the layer of perennial grasses, an increase in humus is observed up to 2.1%. That is, in the first link there is an increase in the humus content in the soil. (data of the department of agroecology of soils).

The introduction of organic and mineral fertilizers after harvesting winter wheat influenced the humus content of the soil in different ways. With siderates, a considerable amount of fresh organic matter enters the soil and a significant activation of humus occurs. With the biomass of green fertilizer, 132 kg / ha of nitrogen, 52.9 kg / ha of phosphorus and 176 kg / ha of potassium enter the soil.

In the course of its decomposition, these nutrients replenish the soil fund of nutrients, which provides additional nutrition for subsequent crops of crop rotation.

So, the aftereffect of the pea-seed mixture provided an increase in humus in subsequent sugar beet crops to 2.2%. The same result was obtained from the application of 20 tons per hectare of manure.

After sugar beet on soybean crops, the content of humus in the soil varied depending on the aftereffect of fertilizers 2.0-2.3%. These tables indicate the effectiveness of cultivation of legumes (in this case - soybeans). Soybean in this indicator of soil fertility is a good predecessor for other crops.

The obtained results indicate that in the 8-field grass-and-grained rotate crop rotation, a positive net balance of humus in the soil is formed for soil rotation. This is achieved, mainly due to the cultivation of alfalfa in the first link, the smell of organic fertilizers and soybeans before the culminating crops of crop rotation.

In the rotation with a short rotation (3-fold), the more frequent green manure and the cultivation of soybeans-legumes also contributed to the increase in the humus potential of the light chestnut soils studied. The priming of the vetch mixture allowed maintaining the optimum humus content in the soil for two years, especially in 2005, which was characterized by dry spring, which probably contributed to the strengthening of humification processes in the soil.

The humus content in the soil is largely determined by the cultivated crop and its predecessor, and its dynamics and seasonal balance by the climatic conditions of the year.

The obtained results indicate that on irrigated light chestnut soils humus potential is maintained by cultivation of alfalfa, soybean and using biologic means. Alfalfa provides a higher content of humus in the soil, which favorably affects the sown crops by its formation and turnover.

In the 8-hollow and 3-hollow biologized crop rotations, a positive humus balance was formed for rotation. This allows us to conclude that the use of green manure in the system: soil - organic fertilizers - the plant can provide a non - deficit balance of organic matter in irrigated agriculture.

So, on the basis of the data obtained, it is obvious that biologization means in crop rotations are economically and environmentally justified. But, despite the positive scientific results obtained, for Kazakhstan organic farming and production of organic products is still a "young sector", since there is no single concept and for the widespread introduction of the organic system in production it is necessary to solve the following tasks in the crop, livestock and processing industry:

– In the field of crop production: wide diversification, increased production of agricultural products, improvement of the basic conditions for reproduction of soil fertility, increased productivity of irrigated land and production of ecologically clean products, involve-ment in the agricultural turnover of currently unused lands and 6.8 million hectares of reserve land; restoration of 600 thousand hectares of previously used irrigated land;

– In the livestock sector: building up the export potential of meat, developing transhumant livestock, developing feed production, restoring and watering degraded pastures. It is planned to water 20 million hectares of pastures from 63 million hectares;

– In the sphere of processing: transition to international quality standards, technical and technological re-equipment of production, etc.

Conclusion.

1. Organic fertilizers (green mass of peas -11,7 t / ha, manure -20 t / ha), introduced under the sugar beet of the first link of 8-field crop rotation, enable the polymerisation processes and the formation of humic components in the soil. The activity of polyphenol oxidase increased from 3.7 to 5.5 mg, the activity of peroxidase does not exceed 5.7 mg. The coefficient of humus accumulation in the arable soil horizon of these variants ranges from 92 to 123%, the humus content increases from 1.9 to 2.0%.

2. In 3-rotary crop rotation, synthesis processes humus mineralization are less intensive, but more balanced. The vetch of the mixture improves the activity of polyphenol oxidase to 3.9 mg, reduces the activity of peroxidase to 3.8 mg, increases the humus content of 107%, and maintains the humus content in the soil at 1.82% until the end of rotation.

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СУАРМАЛЫ ЖЕРЛЕРДІҢ ӨНІМДІЛІГІН АРТТЫРУ ҮШІН БИОЛОГИЯЛЫҚ АУЫСПАЛЫ ЕГІСТІҢ ЖӘНЕ ЖАСЫЛ ТЫҢАЙТҚЫШТАРДЫҢ ТИІМДІЛІГІ

Аннотация. Топырақ құнарлылығын қалпына келтіру, суармалы жерлердің өнімділігін арттыру және биологиялық ауыспалы егістік жүйесінде экологиялық таза өнімдерді алудың негізгі шарттарын жетілдіру бойынша зерттеулер мен нәтижелер келтірілген.

Түйін сөздер: биологиялық ауыспалы егіншілік, жасыл тыңайтқыштар, топырақ, құнарлық, ауылшаруашылық дақылдардың өнімділігі.

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ЭФФЕКТИВНОСТЬ БИОЛОГИЗИРОВАННЫХ СЕВООБОРОТОВ И ЗЕЛЕНЫХ УДОБРЕНИЙ ДЛЯ ПОВЫШЕНИЯ ПРОДУКТИВНОСТИ ОРОШАЕМЫХ ЗЕМЕЛЬ

Аннотация. Представлены результаты исследований по улучшению основных условий воспроизводства плодородия почв, повышения продуктивности орошаемых земель и получение экологически чистой продукции в системе биологизированных севооборотов.

Ключевые слова: биологизированные севообороты, зеленое удобрения, почва, плодородия, урожайность сельскохозяйственных культур.

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