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# ENVIRONMENTAL PROBLEMS OF APPLICATION OF FERTILIZERS

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**Keywords:** chemicals in agriculture, environmental problems, soil pollution, resource-saving technology, fertilizers, soybeans.

**Abstract.** This article highlights the results of the study of environmental problems such as soil contamination in the application of fertilizers and efficiency of resource-saving technology of soybean cultivation with elements of intensification of agriculture is the optimum rate of fertilizer in increasing the productivity of agro-ecosystems.

The authors highlighted that, firstly, the use of mineral fertilizers is the effective technique to preserve and improve soil fertility, yield crop growth and maintain a favorable phytosanitary condition of agroecosystems. And secondly, in the environmental assessment of the effects of application of chemicals agriculture should take into account changes in soil, groundwater, air and living organisms under the influence of fertilizers. Since this leads to a decrease in product quality, improvement in its content, and residual amounts of nitrate fertilizers.

Substantiated environmental problems of use of fertilizers in the cultivation of major crops – soya in the conditions of the southeast of Kazakhstan. Optimal parameters of elements of resource-saving technologies aimed at improving the environment and improving the efficiency of agriculture chemicalization also revealed violations of the ecological balance of the agro-ecosystem and developed.

In determining environmental impacts chemicalization agriculture under specific conditions and for a study of environmental problems chemicalization agriculture authors studied the ways of rational use bioenergiticheskogo potential agro-ecosystems, and soil pollution with heavy metals in the application of fertilizers and effective resource cultivation technology with (elements intensive technology) optimal standards of mineral fertilizers increasing the productivity of soybean agroecosystems.

Thus, the article proved that mineral fertilizers in optimal standards are one of the main factors of stabilization of the ecological condition of the soil, to increase productivity of soybean plants at resource-saving technologies of cultivation in irrigated south-east of Kazakhstan.

**Introduction.** To date world experience of agricultural development indicates that the use of chemicals in agriculture is one of the main ways of its intensification, the key to improving the productivity of arable land, labor productivity, thus improving the economic situation in the sector of agricultural production [1, 2].

The most efficient way to conserve and enhance soil fertility, increase crop yields and maintain a favorable phytosanitary condition of agroecosystems is the application of chemical fertilizers and pesticides. However, along with the positive effects should recognize the negative impact of application of chemicals on the environment in agriculture [3-5]. These negative changes in the agroecosystem are the result of processes of imbalances and excessive impact on the environment with an inhibitory effect on agrophytocenoses and soil.

The soil cover is more exposed to contamination, degradation and destruction, as all processes in agro-ecosystems associated with transformation, accumulation and migration of substances in the soil. Soil is a filter incoming toxins, and the most important factor in their transformation. When assessing the impact of environmental chemicalization agriculture should take into account changes in soil,

groundwater, air and living organisms under the influence of soil application of fertilizers and pesticides ameliorants, and under the influence of growing crops. This leads to a reduction in the quality of products, increase its content of nitrates and pesticide residues [6].

Ultimately, the environmental violations results in economic losses due to the lower productivity of arable land and lower efficiency of invested funds chemicals in agriculture [7, 8]. That is, there are opportunity costs as additional costs for the preservation of agricultural products, soil fertility, to their treatment, to clean air, water conservation public health. Despite the violation of environmental and economic balance in the agroecosystem, there is widespread use of chemicals without considering environmental factors.

In this connection, it is necessary to justify the environmental aspects of use of fertilizers in the cultivation of staple crops – soybeans in a south-east of Kazakhstan. Also identify the ecological imbalance agro-ecosystems and to develop the optimum parameters of the elements of resource technology aimed at improving the environment and improving the efficiency of agriculture chemicalization.

**Materials and methods Sampling area**. The object of research is a unique culture-soybean (cultivar Eureka), short – rotation shift of crop rotation.

As a control in the experiments served as the traditional technology of soybean cultivation in accordance with the recommendations of the farming systems Almaty region [9, 10]. Field experiments and experimental studies conducted by conventional classical methods: experiments and observations. Methodical withstand all the requirements for the procedure of bookmarks and field experiments conducted by B. A. Dospehov (1985) and according to the guidelines of Boiko A. T. and Karyagin Y. G. «Vita»OJSV [11, 12]. Biometric and phenological observations were carried out in accordance with the recommendations of the Institute of field crop and vegetable production, and techniques STATE crops – growing of cereals, legumes and oilseeds [13, 14, 15].

The experimental materials processed by variance, correlation and regression analysis by Dospehov B.A., and analysis of Novikov A. M., Novikov D. A. [11, 16].

To determine the content of heavy metals in the soil was used atomic absorption spectrophotometer Shimadzu AA7000, with hollow cathode lamps made of the elements Fe, Zn, Cu, Pb, K. For the sample preparation method study of RD 52.18.286-91 [17] was used , the comprising treating the samples in a microwave "Minotaur 2" PU 12-2009.

**Sample collection and preparation.The results of research.** In determining environmental impacts and economic evaluation of application of chemicals in agriculture specific conditions we studied ways of rational use of bioenergetics potential of agro-ecosystems. To justify the environmental dimension of agriculture chemicalization we studied soil pollution with heavy metals in the use of fertilizers and resource-efficiency cultivation technology with elements of intensive technology as the optimal rate of fertilizer in increasing the productivity of agro-ecosystems [18].

According to domestic and foreign researches the use of fertilizers and increase crop yields are directly dependent [19, 20]. With low fertilizer use, and vice versa in the case of excess of applications, there are environmental problems with a concomitant deterioration in the economic situation of the local and global. In case of imbalance of nutrients in the soil plants reduce its productivity and crop quality. Similarly actions appear redundant rules apply fertilizer.

Fertilizers applied to soil enter into complex interactions with her and their fate depends on its chemical and physical properties. The soil, as a component of the biosphere is rather specific, since it stands as a buffer that controls the transfer of chemical elements and compounds.

The disadvantage of many of fertilizers can be attributed to the presence of heavy metals (cadmium, lead, nickel, etc.). The most contaminated with heavy metals phosphorus and complex fertilizers. The use of phosphate and complex fertilizers leads to environmental pollution compounds of fluorine, arsenic. Into the soil soluble phosphate fertilizers, in considerable extent absorbed by the soil and become inaccessible to plants and do not move in the soil profile. It was found that the first culture use of phosphate fertilizers only 10–30% $P_2O_5$, and the rest amount remains in the soil and undergoes various transformations.

In the context of our research cropping was carried out with intensive technology, which used higher doses of mineral fertilizers. A striking example can serve $N_{60}R_{180}K_{90}$ recommended rates of mineral fertilizers for crops of soybeans one of the largest agricultural enterprises - JSC "Vita" located on the south-east of Kazakhstan and engaged in the cultivation of this valuable legumes, while oilseeds. During

the comparative assessment of the studied doses of mineral fertilizers were used ammonium sulfate, superphosphate and muriate of potash.

Ammonium sulfate ($(NH_4)_2SO_4$) – average salt of sulfuric acid contains 21% nitrogen and 24% sulfur. From the entered norm of fertilizers plants assimilate cation $NH_4$ + ammonium sulfate is much more intense than the anion $SO_4$ - as the nitrogen the plants need a much larger amount than sulfur. This process is accompanied by the destruction of the soil contained in the basic compound that increases the acidity, especially with long-term use of ammonium sulfate to the same sites. Thus, ammonium sulphate is a representative of physiologically acidic fertilizers.

In the context of our research meadow-chestnut soil is sufficiently alkaline medium, so ammonium sulfate, which has an acidic environment, is considered the most optimal type of nitrogen fertilizer.

In the composition of ammonium sulfate from heavy metals contained cadmium not more than 0.5 mg/kg (at MPCwa 0.01/0.005 mg/m$^3$), cobalt – 5.0 mg/kg (0.05/0.01 mg/m$^3$), arsenic not more than 2.0 mg/kg (0.04/0.01 mg/m$^3$), nickel not more than 4.0 mg/kg (0.05 mg/m$^3$), lead is not more than 32 mg/kg (0.01/0.005 mg/m$^3$), copper is not more than 33 mg/kg (1/05 mg/m$^3$).

Simple superphosphate ($Ca(H_2PO_4)_2$) – is a highly effective granular phosphorus fertilizer. It is made from phosphate rock, sulfuric acid and phosphoric acid and ammonia. It is used for the core, pre-plant, at planting and fertilizing all crops in all types of soil. The heavy metals are contained in the following ranges: lead (Pb) not more than 20 mg/kg, cadmium (Cd) – not more than 0.5 mg/kg, arsenic (As) not more than 2 mg/kg, chromium (Cr 6+) – not more than 6 mg/kg.

It is well known that in the year of fertilizer application plants use about 30–50%, the rest remains in the soil as the aftereffect of fertilizers [19, 20]. It is therefore necessary to monitor the levels of HM.

Given the foregoing, we carried out a comparative assessment of the impact of the application of the four variants of the mineral fertilizers in conventional and resource-saving technologies of cultivation of soy on the content of heavy metals. In the traditional technology of cultivation of soy is studied as a control variant without fertilizers and $N_{60}P_{180}K_{90}$ as recommended dose for area studies.

When use of resource-saving technologies of cultivation of soybean - phosphorus fertilization normal $P_{60}K_{30}$, and full $N_{30}P_{60}K_{30}$. According to the research content of heavy metals in the 0–20 cm soil layer was different in exploring options (table).

Soil contamination by heavy metals in the use of mineral fertilizers, depending on the technology of cultivation of soy

| Heavy metals | Traditional technology | | Resource saving technology | | MAC level, mg/k |
|---|---|---|---|---|---|
| | Without fertilizers | $N_{60}P_{180}K_{90}$ | $P_{60}K_{30}$ | $N_{30}P_{60}K_{30}$ | |
| Cr | 0, 58 | 2,78 | 0,54 | 0,62 | 6,0 |
| Pb | 0,49 | 2.34 | 0,514 | 0,539 | 6,0 |
| Zn | 0,422 | 0,46 | 0,377 | 0,462 | 23,0 |
| Cu | 0,123 | 0,37 | 0,125 | 0,209 | 3,0 |
| Cd | 0,049 | 1,18 | 0,62 | 0,85 | 20,0 |

In conventional technology without application of mineral fertilizers the soil is low in virtually all elements of heavy metal in particular copper – 0.123 mg/kg and zinc – 0.422 mg \ kg, respectively, 24.4 and 54.5 times lower than the MAC (3.0 and 23.0 mg/kg). There is a tendency to increase a content of heavy metals [21] in the cases of mineral fertilizers in the resource-saving technologies. Also, a significant increase in the concentration of heavy metals in application of $N_{60}P_{180}K_{90}$ – recommended dose for area studies. When making a long-term dose of fertilizer in the Cr content 0-10sm layer increases from 0.58 to 2.78 mg/kg soil.

By the nature of the accumulation of heavy metals in the meadow brown soil under crops of soybeans should be noted that the Pb content ranged from 0.49 to 2.34 mg/kg, Zn – 0,422–0,46 mg/kg Cu changed within 0,123–0,37 mg/kg, Cd – 0,049–1,18 mg/kg of soil and was significantly lower at 17.6 MPC, respectively; 50.0; 8.1; 16.9 times.

Thus, the content of heavy metals in the soil in conventional technology formed a number in descending order: Cr>Pb>Zn>Cu>Cd. A different picture emerges from a mineral fertilizers with a rather

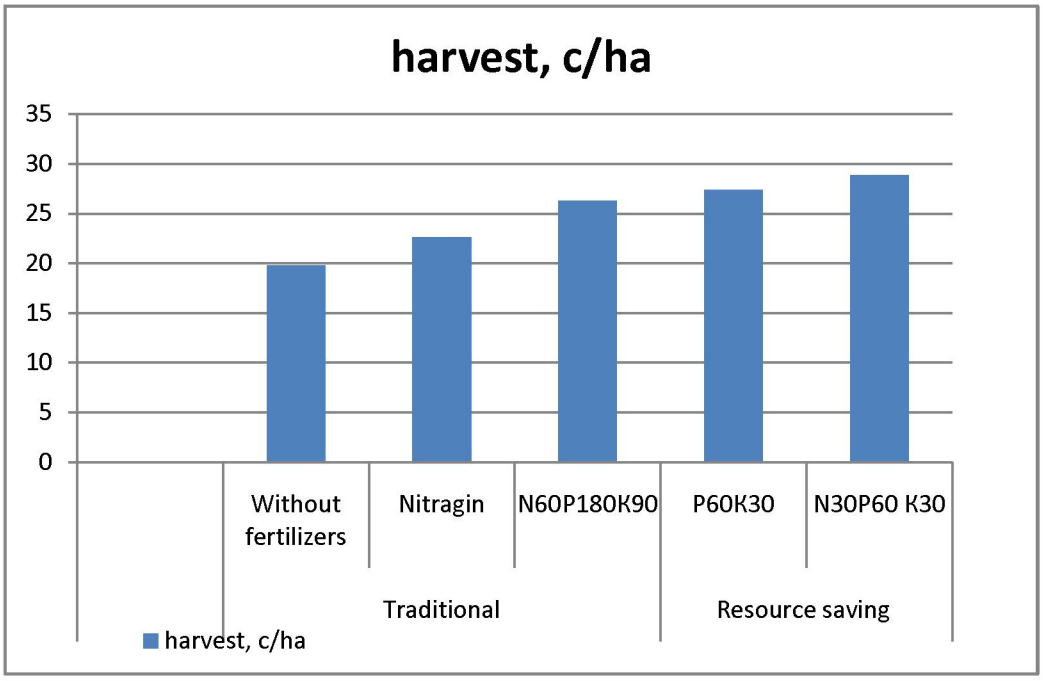
exaggerated doses ($N_{60}P_{180}K_{90}$), where the number of contents heavy metals looks as follows Cr>Pb> Cd> Zn> Cu.

In the distribution of Cd in the soil profile was observed following law-dimensionality. The largest number of Cd observed in the arable horizon (0,62–0,85 mg/kg) on a variant using $P_{60}K_{30}$ and a complete set of mineral fertilizers – $N_{30}P_{60}K_{30}$ at soil safeflat cut tillage.

The highest content of Cr - 0,54-0,62 mg / kg in applications of fertilizers ($P_{60}K_{30}$ and $N_{30}P_{60}K_{30}$) for resource-saving technology is much lower than the MPC level (ie, 11.1 and 9.7 times). In this embodiment, the Cd content was more inflated and 0.62 and 0.82 mg/kg, they were below the MPC level in 32.2 and 23.5 times. It should be noted that the content in the soil of mobile forms of heavy metals in the fastest time. Reasons for changes may be different in most cases agefluctuations are explained by changes in the plants, in the intensity of absorption of chemical elements.

Thus, scientifically based application of fertilizers in the cultivation of soybeans does not lead to the accumulation of heavy metals in the topsoil. When environmental conditions of resource-saving technology for soil cultivation of soybeans is optimized, where the content is much lower heavy metals MPC level 9,7–11,1 times for Cr, Pb 17.6 times, Zn 50.0 times, 8.1 Cu and Cd 16.9 times. It is proved that an alternative technology in the application of mineral fertilizers in the dose $P_{60}K_{30}$ and $N_{30}P_{60}K_{30}$ provides an environmentally safe ecosystem of soybean cultivation with the subsequent improvement in the nutrient regime of the soil and increase crop productivity.

Soybean yields under control with conventional technology without fertilizers is only 19,8 c/ha. Against this background, when soybean seeds were treated before sowing nitragin, soybean yields increased by 2.8 c/ ha. (figure).




Soybean yields, depending on the application of mineral fertilizers, kg/ha

Application nitragin has on symbiotic activity, increases the number and weight of nodules on the roots of soybean plants that improve nitrogen nutrition of crops.Soybean responds well to make phosphate fertilizers, especially against the background of low levels of available phosphorus in the soil, in our case studies.

When resource-saving technology of phosphorus fertilization on the background of seed treatment nitragin soybean yields increased from 19,8 to 27,4–28,9 c/ha.

Full fertilization $N_{30}P_{60}K_{30}$ for the study of resource-saving technologies has contributed to a further increase, ie, yield increase of 9.1 c/ha.

Thus, it is proved that fertilizers are major factor in the stabilization of the ecological condition of the soil, to increase productivity of soybean plants in the resource-saving technologies of cultivation under irrigation in the southeast of Kazakhstan.

**Conclusion.** Established optimal standards ($P_{60}K_{30}$ and $N_{30}P_{60}K_{30}$) of fertilizers allow to reveal hidden forms of violations of ecosystem resilience in comparison with the traditional technology of soybean cultivation in the inflated standards $N_{60}P_{180}K_{90}$ prolonged use. When making this recommended dose observed increase in the content of heavy metals, where Cr content 0-10 sm layer increased significantly from 0, 58 mg/kg to 2,78 mg/kg soil. In the context of the south-east of Kazakhstan prolonged use of excessive regulations $N_{60}P_{180}K_{90}$ disturbs the stability of the agro-ecosystem, which increases the level of soil contamination with heavy metals, disrupted ecological condition agrophytocenosis and reduced productivity of crops to 13,1%.

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## МИНЕРАЛДЫ ТЫҢАЙТҚЫШТАРДЫ ҚОЛДАНУДЫҢ ЭКОЛОГИЯЛЫҚ ПРОБЛЕМАЛАРЫ

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**Түйін сөздер:** егіншілікті химияландыру, экологиялық проблемелар, минералды тыңайтқыштар, топырақтың ластануы, ресурсүнемдеу технологиясы, майбұршақ.

**Аннотация.** Мақалада минералды тыңайтқыштар қолданғандағы топырақтың ластануы сияқты экологиялық проблемалар және минералды тыңайтқыштардың оптималды нормаларын қолдана отырып соя өсірудегі ресурсүнемдеу технологиясының агроэкожүйесі өнімділігін арттырудағы тиімділігін зерттеу нәтижелері көрсетілген.

Авторлар біріншіден минералды тыңайтқыштар қолдану топырақтың құнарлылығын арттыру, ауылшаруашылық дақылдарының өнімділігін көтеру және агроэкожүйенің қолайлы фитосанитарлық жағдайын сақтау үшін тиімді тәсіл екенін, екіншіден егіншілікті химиялық өңдеуді экологиялық бағалау жағдайында минералдық тыңайтқыштар әсерінен топырақтың, жерасты суларының, ауаның және тірі организмдердің өзгеріске ұшырайтынын ескеру керек деп атап өтеді.

Қазақстанның оңтүстік шығыс аймағында көрнекі дақыл – сояны – өсіруде минералды тыңайтқыштар қолданудың экологиялық проблемелары анықталған. Сондай-ақ агроэкожүйенің экологиялық тепе-теңдігі бұзылуы айқындалып, экологиялық жағдайды жақсартуға және егіншілікті химияландыру тиімділігін арттыруға бағытталған ресурсүнемдеу технологиясы элементтерінің оптималды параметрлері жасалды.

Егіншілікті химияландырудың нақты жағдайдағы экологиялық салдарын анықтау және экологиялық проблемаларды дәлелдеу үшін авторлар агроэкожүйенің биоэнергетикалық потенциалын рационалды пайдалану жолдарын, сондай-ақ минералды тыңайтқыштарды қолданғанда топырақтың ауыр металдармен

ластануын және ресурсүнемдеу технологиясының агроэкожүйе өнімділігін арттырудағы тиімділігі қарастырылған.

Мақалада минералды тыңайтқыштар оптималды нормада пайдаланылған жағдайда топырақтың экологиялық жағдайын тұрақтандыруда басты фактор болады деп дәлелдейді, ол өз кезегінде Қазақстан оңтүстік шығыс жағдайында ресурсүнемдеу технологиясын қолдана отырып өнімділікті көтеруді қамтамасыз етеді.

## ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ ПРИМЕНЕНИЯ МИНЕРАЛЬНЫХ УДОБРЕНИЙ

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**Ключевые слова:** химизация земледелия, экологические проблемы, минеральные удобрения, загрязнение почвы, ресурсосберегающая технология, соя.

**Аннотация.** В статье освещены результаты изучения экологической проблемы, как загрязнение почвы при применении минеральных удобрений и эффективность ресурсосберегающей технологии возделывания сои с оптимальными нормами минеральных удобрений в повышении продуктивности агроэкосистемы.

Авторами выделяются, что, во-первых, применение минеральных удобрений – эффективный прием для сохранения и повышения плодородия почвы, роста урожайности сельскохозяйственных культур и поддержания благоприятного фитосанитарного состояния агроэкосистем. И во вторых при экологической оценке последствий химизации земледелия следует учитывать изменение почв, грунтовых вод, воздуха, живых организмов под воздействием удобрений. Так как это приводит к снижению качества продукции, повышению содержания в ней нитратов и остаточных количеств минеральных удобрений.

Обоснованы экологические проблемы применеия удобрений при возделывании ведущей культуры – сои в условиях юго-востока Казахстана. Также выявлены нарушения экологического равновесия агроэкосистемы и разработаны оптимальные параметры элементов ресурсосберегающей технологии направленной на улучшение экологической ситуации и повышение эффективности химизации земледелия.

При определении экологических последствий химизации земледелия в конкретных условиях и для обоснования экологической проблемы химизации земледелия авторы изучали пути рационального использования биоэнергитического потенциала агроэкосистемы, также загрязнение почвы тяжелыми металлами при применении минеральных удобрений и эффективность ресурсосберегающей технологии возделывания с (элементами интенсивной технологии) оптимальными нормами минеральных удобрений в повышении продуктивности агроэкосистемы сои.

Таким образом, в статье доказано, что минеральные удобрения при оптимальных нормах являются одним из главных факторов стабилизации экологического состояния почвы, обеспечивающие повышение продуктивности растений сои при ресурсосберегающей технологии возделывания в условиях орошения юго-востока Казахстана.

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