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ECOLOGICAL ASPECTS OF AGROECOSYSTEMS OF SOYBEAN IN THE CONDITIONS OF THE SOUTH-EAST OF KAZAKHSTAN AT CLIMATE CHANGE

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Abstract
In this article results of studying of an environmental problem as pollution of the soil at use of mineral fertilizers are proved against the background of traditional technologies of cultivation of soy. A comparative assessment of efficiency of resource-saving technology with the studied norms of mineral fertilizers in optimization of an ecological situation of an agroecosystem is given. At traditional technology it is revealed that use of the increased norms of N60P180K90 causes increase in level of impurity of the soil heavy metals and decrease in efficiency of the cultivated culture of soy. The value of resource-saving technology in rational use of bioenergy potential of an agroecosystem is revealed and elements of intensive technology with lower norms of mineral fertilizers for increase in efficiency of an agroecosystem of soy are chosen. It is proved that mineral fertilizers are one of the main factors of stabilization of an ecological condition of the soil, providing increase in efficiency of soy at resource-saving technology of cultivation in the conditions of irrigation of the southeast of Kazakhstan. Application evidence-based resource-saving receptions with elements ecologically safe intensive allows to support technologies rather quickly stability of an agroecosystem.

Keywords*: Agroecosystem, environmental problems, soybean, fertilizers, technology*

Introduction

At the present stage aggravation of an ecological situation in Kazakhstan, as well as around the world is considerably connected with the impact of activity of agrarian production on the environment, with rendering the greatest impact on resources of the biosphere (Odum 1986, Shilov 2000). In essence, agrarian production is an ensuring food security of the country using, natural resources of the environment of an agroecosystem. In increase in efficiency of cultures, the applied traditional technologies cause significant resource-technological changes. Results which decrease in fertility of the soil, the maintenance of a humus, destruction of agrophysical indicators and deterioration in the nutritious mode of the soil are. The last years of the XX century agrarian production was focused on use of the intensive technology of cultivation of crops providing application of high doses of mineral

fertilizers and chemical means. Here the duality of processes at use of intensive technology of cultivation of crops was brightly shown. As it besides preservation, increase in fertility and optimization of the nutritious mode of the soil and growth of productivity of cultures, carries negative load of the environment. The soil cover more is exposed to pollution, degradation and destruction (Milashchenko 2000) as all proceeding processes are connected with transformation, accumulation and migration of substances in soils. The great concern is caused now by pollution of the soil and products the toxicant who are contained in the applied fertilizers. First of all, it is radionuclides, fluorine and TM which are natural impurity of agricultural ores. The quantity them depends on initial raw materials and technology of its processing. As on set, and concentration of TM impurity phosphoric fertilizers are the most essential. The composition of domestic phosphates raw materials, especially local fields, is extremely insufficiently studied on contents in them toxic impurity (Postnikov et al 1994). The efficiency of use of fertilizers depends not only on physiological features of plants, norm and a combination of fertilizers, but also on change of the soil environment as biogenous system, on the nature of the processes proceeding in the soil (Zhuchenko 2005). The soil is the ecological communication center of the biosphere in which interaction of live and lifeless matter most intensively proceeds. In this regard as especially important question ecological purity of the soil environment at chemicalization farming as on it processes of a metabolism between a lithosphere, the hydrosphere, the atmosphere and organisms living on it become isolated can act (Vrazhnova & Kushnirenko 2003). At ecological assessment of consequences of application of agro methods of technology it is necessary to consider the change of soils connected with the arriving toxicant and their transformations. It leads to decline in quality of products, increase in contents in it residual amounts of mineral fertilizers. At the same time, violations of an ecological situation of an agroecosystem bring to the economic losses connected with smaller efficiency of an arable land and smaller efficiency of the made investments of technology. That is there are such alternative expenses as additional costs of preservation and restoration of fertility of soils. Despite violation of ecology-economic balance in an agroecosystem, universal application of means of chemicalixation without ecological factors in the conditions of agriculture of Almaty region is observed. Such situation causes special alarm for deterioration in an ecological situation which makes negative impact on agriculture not only at the moment, but also on prospect. In this regard, studying of an environmental problem of an agroecosystem of soy in concrete soil climatic conditions climate change southeast Kazakhstan has practical value and is very relevant.

In this work results of studying of an environmental problem as pollution of the soil at use of mineral fertilizers are proved against the background of traditional technologies of cultivation of soy. A comparative assessment of efficiency of resource-saving technology with the studied norms of mineral fertilizers in optimization of an ecological situation of an agroecosystem is given.

Materials and Methods

In this regard, environmental problems of agroecosystems of soy in the conditions of the southeast of Kazakhstan are studied by classic methods as observation and an experiment. Experimental researches were conducted in the territory of the educational-experimental station (EES) of the Kazakh national agricultural university of Agrouniversity which is located in a northwest part of Almaty region. Environmental problems use of mineral fertilizers against the background of traditional and resource-saving technology of cultivation of soy in 2012-2018 were studied. Objects of a research are unique leguminous culture - soybean (a grade Eureka), it is short - a rotational fruitshifts crop rotation. Control in experiences was served by traditional technology of cultivation of soy according to the recommendations of the System of farming of Almaty region (2005). Field experiments and pilot studies are conducted by the standard classic methods: experiment and observation. All methodical requirements imposed to a technique of laying of field experiments are sustained and were carried out according to B.A. (Dospekhov 1985) and according to Methodical Recommendations, 2004 (Boyko & Karyagina 2004) by JSC Vita. Biometric and phenological observations were made according to the recommendation of Institute of field husbandry and vegetable growing, and the Method of STATE crops of cultivation of grain, leguminous and oil-bearing crops. The received experimental materials are processed by a statistical method. For determination of content of heavy metals in the soil the atomic and absorbing Shimadzu AA7000 spectrophotometer, with lamps with the hollow cathode, made of the elements Cr, Zn, Cu, Pb, Cd was used. For preparation of samples for a research used the RD 52.18.286-91 method.

Results and Discussion

In the conditions of ours researches cultivation of valuable leguminous and at the same time oil-bearing crop was carried out on intensive traditional technology, with application of the raised dose of N60P180K90 of mineral fertilizers. This dose of mineral N60P180K90 fertilizers it is recommended to one of the large agroenterprises - JSC Vita of Kazakhstan which is in the territory of the southeast and which is engaged in cultivation of soy and is brought by scattering before hulling of an eddish at the rate of 330 kg/hectare. Soy is characterized by consumption of a large number of mineral elements, uneven on phases of development. Creating big vegetative weight and forming seeds with the high content of fat and protein (Zubkov 2004), soy needs intensive mineral food. According to researchers, 8-10 kg of nitrogen, 2.0-3.5 kg of phosphorus and 3-4 kg of potassium are spent for formation of 1 c of grain of soy on average (Gamzikov 2007). Considering the above, for justification of environmental problems application of the overestimated doses of mineral fertilizers at traditional technology of cultivation of soy we carried out the comparative assessment by two options of a dose of mineral fertilizers. Therefore, at traditional technology of cultivation of soy the comparative assessment of prolonged use of the raised doses of mineral fertilizers is carried out and the nutritious mode of the soil is defined. Development

of resource-saving ecologically safe technologies of cultivation of soy is reached by means of technology with the minimum processing of the soil and with application of optimum doses mineral fertilizer. For identification and the level of pollution of the soil heavy metals at use of mineral fertilizers (Ilyin 2004, Chernykh, et al 2003) were carried out against the background of traditional and resource-saving technologies of cultivation of soy. At traditional technology are established that at prolonged use of high doses of mineral N60P180K90 fertilizers the amount of heavy metals in a root habitable layer of earth significantly increases. By results definition the content of the heavy metals (HM) in 0-20 cm a layer of earth was various by the studied options. Against the background of traditional technology of cultivation of soy, without introduction of mineral fertilizers the soil is characterized by the low maintenance practically of all types of heavy metals. Especially low contents noted cadmium - 0.35 mg\kg and copper - 0.41 mg \kg that respectively on 57 and 7 times it is lower than the maximum allowable concentration level. Content of the defined following heavy metals as Cr, Pb, Zn in the meadow-chestnut soil does not exceed their maximum allowable concentration.

It is established that at prolonged use of the raised doses (N60P180K90) of mineral fertilizers the amount of heavy metals in a root habitable layer of earth significantly increases. At introduction of mineral fertilizers in N60P180K90 dose the amount of the arrived cadmium to the soil increases from 0.35 mg \kg to 8.6 mg/kg, - is lame - from 0.61 to 5.29 mg/kg, - lead from 0.57 to 4.83 mg/kg, - zinc from 1.13 to 10.9 mg/kg and - copper from 0.41 to 3.2 mg/kg. Content of the listed heavy metals (HM) in an arable layer of earth after application of the overestimated doses of mineral fertilizers sharply increases several times (Table 1).

Table 1. Pollution of the soil heavy metals at use of mineral fertilizers depending on technology of cultivation of soybean (mg/kg)

Heavy metals mg/kg	1 background - Traditional technology		2 background - Resource-saving technology		Threshold limit value, mg/kg
	Without fertilizers	$N_{60}P_{180}K_{90}$	$P_{60}K_{30}$	$N_{30}P_{60}K_{30}$	
C r	0.61±0.018	0.57±0.017	0.74±0.025	0.81±0.017	6.0
Pb	0.57±0.017	4.83±0.13	1.29±0.04	1.61±0.04	6.0
Zn	1.13±0.053	1.29±0.04	1.38±0.03	2.54±0.05	23.0
Cu	0.41±0.012	3.2±0.064	0.69±0.01	0.72±0.02	3.0
Cd	0.35±0.01	8.6±0.24	1.28±0.03	1.82±0.05	20.0

Content of the listed heavy metals (HM) in an arable layer of earth after application of the overestimated doses of mineral fertilizers sharply increases several times. In Cr given a case the contents and Cd Pb – by 8 times, Zn – the 10th time increased by 24 times. It should be noted that the content of these heavy metals (HM) does not exceed value of threshold limit value yet (maximum allowable concentration, mg/kg). But, create big risk to pollution of the soil heavy metals as chrome, Cr keeping of whom in three years increased from 0.61 mg/kg to 5.29 mg/kg and lead,

Pb keeping of whom also increased from 0.57 to 4.83 mg/kg and is in limits of maximum allowable concentration and create the risking range pollution of the soil.
Pollution of the soil at traditional technology is revealed application of the overestimated doses (N60 P180K90) of mineral fertilizers under soy crops by copper (Cu) which content raises by eight times, from 0.41 to 3.2 mg/kg of the soil that above a threshold of admissible concentration which maximum allowable concentration is only 3.0 mg/kg of the soil. On the level of impurity of the soil copper belongs to highly dangerous classes that proves on a high environmental problem of application of high doses of mineral fertilizers traditional technologies of cultivation of soy. In the solution of this environmental problem of an agroecosystem influence of a dose and a combination of types (P60K30 and N30P60K30) of mineral fertilizers at the resource-saving technology of cultivation of soy developed by us are studied. At resource-saving technology results of application of P60K30 of fertilizers and a full range of types of mineral fertilizers - N30P60K30 show that the greatest number of Zn and Cd is noted on these options. Comparative largest content of Zn = 1.38-2.54 mg/kg it is revealed in options of use of mineral fertilizers according to P60K30 and N30P60K30. Their value is much lower than the maximum allowable concentration level (i.e. in 9.7 and 6.5 times). The maintenance of Cd higher and makes 1.28 and 1.82 mg/kg, they also, are lower in 15.7 maximum allowable concentrations and 10.9 times. It should be noted that contents in the soil of a mobile form of heavy metals is dynamic in time and does not cause danger of pollution of the soil of TM. Thus, at resource-saving technology ecological conditions of the soil for cultivation of soy are optimized, the content of heavy metals is much lower than maximum allowable concentration, for Sg 8.1-7.4 times, Pb by 4.6-3.7 times, Zn by 16.7-9.0 times, Cu in 4.3-4.2 and Cd by 15.6-10.9 times. The received results show that the resource-saving technology at introduction of mineral fertilizers in a dose of P60K30 and N30P60K30 provides ecologically safe environment for soy cultivation. Therefore, there is a full justification to consider that it by scientifically based doses of mineral fertilizers at cultivation of soy is P60K30 and N30P60K30 which do not accumulate heavy metals in an arable layer of earth, with the subsequent improvement of the nutritious mode of the soil (Suleymenova et al 2014) and increase in efficiency of culture. The comparative assessment of traditional and resource-saving technologies for justification of the nutritious mode and increase in efficiency of soy is carried out. It is revealed that at traditional technology of cultivation of soy during the critical period of development - soy branching security of crops with mobile forms of nutrients low, (Suleymenova & Razmanova 2012) and at introduction of the raised dose of fertilizers their contents increase only to the average level (Fig. 1).

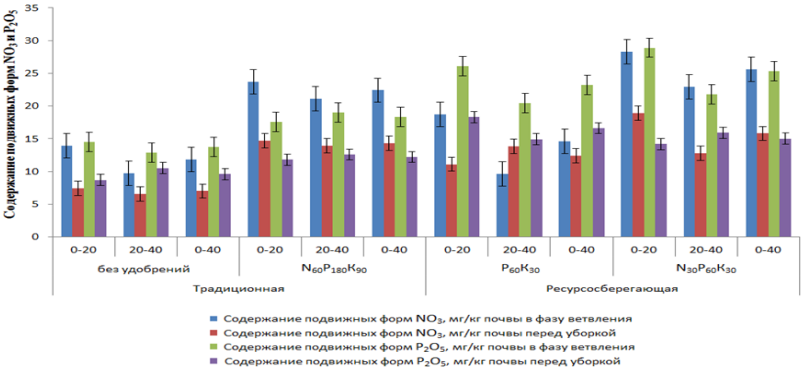

Figure 1. Dynamics of mobile forms of soil nutrients depending on the technology of cultivation of soybean

At resource-saving technology there is an optimum nutritious mode of the soil. Application of fertilizers in a dose of P60K30 and N30P60K30 the maintenance of mobile forms of nitrate nitrogen increases up to 25.6 mg/kg with fluctuation on the horizons from 22.9 mg/kg to 28.3 mg/kg on the soil horizons. At introduction of P60K30 mobile forms of phosphorus are made by 21.2 mg/kg with fluctuation from 17.7 mg/kg and 24.8 mg/kg on the soil horizons that for 13.3% and 39.4% respectively it is more, than in control option at traditional technology of cultivation of soy. Improves ensuring need of soy for nitrogen, especially during the critical period of development when there is a progressive growth of green vegetative material of a plant and has significant effect on productivity of soy (Table 2).

Table 2. Productivity of soy depending on introduction of mineral fertilizers, c/hectare (An average for years of researches)

Technology of cultivation		Use of fertilizers	Productivity, c/hectare	Increase in	
				c/hectare	%
	Traditional	Without fertilizers	19.3±0.61	St	-
		$N_{60}P_{180}K_{90}$	24.8±0.67	5.5	28.5
Resource-saving	Mini-Till, Plainly carved processing of the soil on depth the 12-14th cm	Without fertilizers	21.9±0.72	2.6	13.0
		$P_{60}K_{30}$	26.5±0.64	7.2	37.3
		$N_{30}P_{60}K_{30}$	27.8±0.77	8.5	44.0
	Mini-Till, Plainly carved processing of the soil on depth the 16-18th cm	Without fertilizers	21.5±0.68	2.2	11.4
		$P_{60}K_{30}$	26.3±0.73	6.0	31.1
		$N_{30}P_{60}K_{30}$	26.4±0.71	7.1	36.7

The productivity of soy at traditional technology without fertilizers is only 19.3±0.61 c/hectare. Introduction of the recommended overestimated dose of mineral fertilizers at traditional technology – N60P180 K90 productivity of soy increases up to 24.8±0.67 c/hectare. Full application of fertilizers in a dose of 330 kg/hectare at traditional technology promoted receiving an additional harvest within 5.5 c/hectare. It should be noted that soy well reacts to introduction of phosphoric fertilizers, especially against the background of the low content of mobile phosphorus in the soil as under our conditions researches. When studying influence of resource-saving technology with introduction of phosphoric fertilizers is revealed that the productivity of soy increases up to 31.1% - 39.4%. Therefore, on this option and at joint introduction of phosphorus-potassium fertilizer the productivity of soy increases up to 26.9±0.64 c/hectare. Full application of fertilizers (N30P60K30) at the studied resource-saving technology promoted additional increase where the increase of a harvest makes 7.1 c/hectare. Comparative assessment of responsiveness of soy on the level of mineral food showed that soy distinctly reacts to changes of the nutritious mode of the soil. And in the conditions of our researches soy positively reacts to introduction of phosphorus-potassium fertilizers, at increase in its productivity on 7.6 c/hectare. And so, mineral fertilizers are one of the main factors of stabilization of an ecological condition of an agroecosystem, providing increase in efficiency of plants of soy at resource-saving technology of cultivation in the conditions of the southeast of Kazakhstan.

Conclusions

Aggravation at the present stage of an ecological situation in Kazakhstan, as well as around the world is considerably connected with the impact of agricultural activity on the environment. The changes of an ecosystem resulting from anthropogenic influence formed a basis of studying of ecological aspects of an agroecosystem of valuable leguminous and at the same time oil-bearing crop, soy and development of receptions resource-saving to technology. The current state use of mineral fertilizers is studied and environmental problems of an agroecosystem at traditional technology of cultivation of soy are proved. Are revealed degree of impurity of the soil by heavy metals and ecotoxicological aspects use of mineral fertilizers. As a result of studying of an environmental problem of agroecosystems of soy in the conditions of the southeast of Kazakhstan it is revealed that against the background of traditional technologies of cultivation of soy, applied (recommended to production) norms of fertilizers (N60P180K90) cause increase in level of impurity of the soil heavy metals. It is established that at prolonged use of high doses of mineral fertilizers the amount of heavy metals in a roothabitable layer of earth significantly increases. At introduction in N60P180K90 dose the amount of the arrived cadmium to the soil increases from 0.35 mg \kg to 8.6 mg/kg, - is lame - from 0.61 to 5.29 mg/kg, - lead from 0.57 to 4.83 mg/kg, - zinc from 1.13 to 10.9 mg/kg and - copper from 0.41 to 3.2 mg/kg. Content of the listed heavy metals (HM) in an arable layer of earth after application of the overestimated doses of mineral fertilizers sharply increases several times, Cr and Cd increased by 24 times,

Pb – by 8 times, Zn – the 10th time. Significant pollution of the soil is revealed by copper (Cu) which content from 0.41 to 3.2 mg/kg of the soil increase that above a threshold of an allowable limit and on the level of impurity of the soil belongs to highly dangerous classes. In the conditions of ours researches very technological culture, soy is characterized by consumption of a large number of mineral elements, uneven on phases of development.Creating big vegetative weight and forming seeds with the high content of fat and protein, soy needs intensive mineral food. At resource-saving technology ecological conditions of cultivation of soy are optimized, the content of heavy metals is much lower than maximum allowable concentration, for Sg 8.1-7.4 times, Pb by 4.6-3.7 times, Zn by 16.7-9.0 times, Cu in 4.3-4.2 and Cd by 15.6-10.9 times. Introduction of mineral fertilizers in a dose of P60K30 and N30P60K30 provides ecologically safe environment and it is necessary to consider them scientifically based doses for soy cultivation which do not accumulate heavy metals in an arable layer of earth, with the subsequent improvement of the nutritious mode of the soil and increase in efficiency of culture.Improves ensuring requirement of soy to the nutritious mode, especially during the critical period of development when there is a progressive growth of green vegetative material of a plant and has significant effect on productivity of soy, in the conditions of our researches soy positively reacts to introduction of phosphorus-potassium fertilizers, at increase in its productivity on 7.6 c/hectare. Thus, mineral fertilizers are one of the main factors of stabilization of an ecological condition of an agroecosystem, providing increase in efficiency of plants of soy at resource-saving technology of cultivation in the conditions of the southeast of Kazakhstan.

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