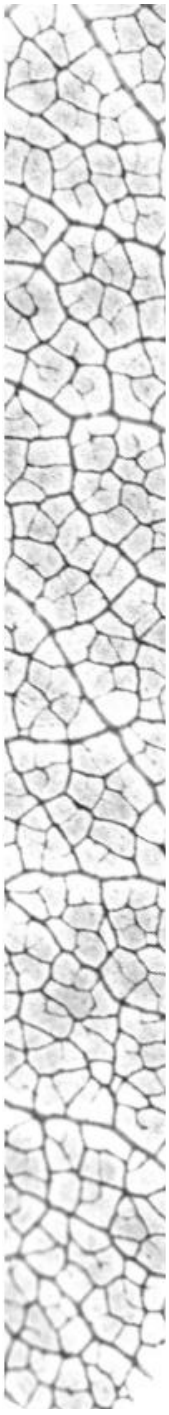

EurAsian Journal of BioSciences
Eurasia J Biosci 14, 493-500 (2020)

Efficiency of bioecological features of soybean in increasing soil fertility and its productivity in the conditions of south-east Kazakhstan

Elnara Kuandykova [1*], Naziya Suleimenova [1], Meruyert Kurmanbayeva [2], Baglan Makhamedova [1], Baktigul Raimbekova [1], Aisulu Zhanibekova [1]

[1] Kazakh National Agrarian University, Almaty, KAZAKHSTAN
[2] Al-Farabi Kazakh National University, KAZAKHSTAN
*Corresponding author: 9Elnara@gmail.com

Abstract
In order to increase soil fertility and crop productivity in the conditions of South-east Kazakhstan, we have studied the effectiveness of resource-saving technology in soybean cultivation. The bioecological - nitrogen-fixing features of soybeans were also considered. The experimental study conducted in accordance with the scheme of the full factorial experiment in 2012-2017 on meadow-chestnut soils in South-East Kazakhstan. The article discusses the results of the application of the bioecological potential of culture in the ecologization of technological processes in the agricultural sector (agricultural economics), as a result of which the doses of nitrogen fertilizers are reduced (up to 50%), financial costs for growing crops are reduced, which makes it possible to solve pressing environmental problems. In the experiment, various soybean varieties were studied on the following backgrounds: without fertilizer (control); inoculation of seeds with soybean nitragin; with fertilizer N_{60}P180K90. The duration of the growing season, plant height, mass of air-dry matter, the number and mass of active nodules on the roots, elements of the structure of plant productivity and productivity were determined. It was proved that agro-inoculation of seeds with nitragin can significantly improve the symbiotic nitrogen fixation of soybeans (increases the number of nodules from 16.2 to 35.1 from 21.0-38.0 pcs / 1 plants.). As a result, soybean productivity increases to 34-36%. With such a crop, the ratio of soybeans to terrestrial and underground biomass is ½, which proves the large accumulation of organic roots and residues after harvesting (leaf tops) in the soil, which reduces the dose of nitrogen fertilizers used and contributes to an effective increase in soil fertility. In turn, the structure of the arable soil will stabilized at optimal soil density, which contributes to the normal growth and development of soybean culture. It proved that the minimum technology of tillage is the best agricultural practice providing preservation and improvement of qualitative and quantitative indicators of soil resource and productivity of soybeans.

Keywords: bioecological feature, soybean, inoculation, soil fertility

Kuandykova E, Suleimenova N, Kurmanbayeva M, Makhamedova B, Raimbekova B, Zhanibekova A (2020) Efficiency of bioecological features of soybean in increasing soil fertility and its productivity in the conditions of south-east Kazakhstan. Eurasia J Biosci 14: 493-500.

INTRODUCTION

Current global environmental trends require a new approach to research from scientists, since it is necessary to change the technogenic type of economic development to a sustainable type, focused on solving environmental problems. (Demidenko et al. 2010, Smekalov and Omarova 2011).

The functioning of an agroecosystem is not always adequate to natural ecosystems and has certain destructive consequences, such as changes in parameters and an imbalance of biogeochemical cycles, elements and soil fertility (Mirkin 2011).

Currently, soils are exposed to a number of technogenic factors associated with various types of production, accompanied by a decrease in the biological activity of the soil (Patika 2001, Stakhurlova 2015). It should be noted that today agriculture is the main source of anthropogenic pressure that violates the conditions for the existence of a biocenosis (John 2011, Kaledin et al. 2011).

Organic farming is growing because it supports soil fertility and soil health without affecting the climate. However, comprehensive information on cyclic carbon, nitrogen, phosphorus and sulfur, microbial element stoichiometry and functional diversity of soils is absent

Received: December 2018
Accepted: August 2019
Printed: March 2020

in the world's organic organics. The faster, more efficient, sensitive indicator of soil quality, the biological factors and activity of enzymes that are not accessible to organic farming (Ghosh et al. 2020). Also, cover crops can supply and process soil nitrogen (N) in agroecosystems (Holmes et al. 2019).

Many bradyrisobia can denitrify, but research has so far focused on several model organisms. Were screened 39 different strains of Bradyrhizobium isolated from legume nodules. Half of them could not reduce N_2O, which makes them sources of this greenhouse gas. Most others can denitrify NO_3- to N-2. An analysis of gas kinetics and transcription analysis during the transition to anaerobic respiration revealed a general regulation of nirK, norCB and nosZ (encoding NO_2-, NO, and N_2O reductases) and various regulation of napAB (encoding periplasmic NO_3 reductase). A characteristic feature of all strains producing N-2 was the almost complete difficulty in reducing NO_3 in the presence of N_2O **(**Mania et al. 2019).

Nitrogen-fixing rhizobia, named bacteroids, inhabiting root nodules of legumes are not phosphate limited. Here, we show that the high-affinity phosphate transporter PstSCAB, rather than the low-affinity phosphate transporter Pit, is essential for effective nitrogen fixation of Sinorhizobium fredii in soybean nodules (Hu et al. 2018).

Was studied the effect of an inhibitor of the triazole derivative of paclobutrazole on the formation and function of the soybean-rhizobium complex, the activity of the main nitrogen metabolism enzymes - nitrogenases and nitrate reductases, the morphogenesis and photosynthetic apparatus of soybean plants in connection with the productivity of the culture. Inoculation of seed bacteria with a highly efficient strain of M 8 Bradyrhizobium japonicum followed by treatment of plants with the anti-bibrellin drug paclobutrazole during budding led to significant anatomical and morphological and physiological changes in the function of the source-drain system, which optimized the formation and function of beans. Since the intensity of symbiotic nitrogen fixation is largely dependent on the process of photosynthesis, the use of a flame retardant was effective, since it was followed by an increase in the number of leaves and their total area per plant as a result of branching of the stem (Kuryata et al. 2018).

The reciprocity between bacteria and eukaryotes plays an important role in life history, but the evolution of their compatibility is poorly understood. Here we show that different Sinorhizobium strains can form either nitrogen-fixing nodules or uninfected pseudodules on some cultivated soybeans, being effective microsymbionts of some wild soybeans. However, several well-infected nodules can be detected on commercial soybeans using an inoculum containing a mixed pool of Tn5 insertion mutants derived from an incompatible strain. Reverse genetics and genome sequencing of compatible mutants showed that inactivation of T3SS (type 3 secretion systems) explains this phenotypic change. In these mutations in the T3SS gene cluster, parallel transpositions of insertion sequences (IS) other than the introduced Tn5 prevailed. This genetic and phenotypic change can also be achieved in an experimental laboratory-scale developmental scenario using incompatible wild-type strains as an inoculum. Iss involved in the adaptive evolution of Sinorhizobium strains have a broader distribution of phyletics and replicon than other ISs and prefer target sequences with a low GC% content, which is a characteristic feature of the symbiosis plasmid in which the T3SS genes are located. These results indicate the important role of co-developed IS in the adaptive evolution of rhizobial compatibility (Zhao et al. 2018).

Here, the intensification of agriculture determines the dynamics of microbiological processes, the level of soil fertility and its rational use. Therefore, it is very important to study agricultural methods that minimize the negative consequences of the activities of agricultural production market participants. As you know, one of the most important protein-oil crops in the food market of the world is soybean (Glycine max L. Merrill). Its seeds contain an average of 19-22% oil, 35-44% protein, 18-25% carbohydrates, 12 essential vitamins and a large number of biologically active components (Penchukov et al. 1984).

The symbiosis of soybean with nodule bacteria is one of the most effective plant-microbial systems (Dozorov et al. 2007), which carry out the process of biological fixation of nitrogen, which is of great environmental and practical importance. Soybeans are an important component of farming systems and have the potential to improve soil fertility, increase food security and increase incomes.

Providing agricultural crops with affordable nitrogen is currently a top priority. Inoculation

Legume seeds, soybean with rhizotorfin, based on strains of nodule bacteria, are well known (Beloborova 2012, Kokorina 2010). According to foreign researchers, soybeans in symbiosis with rhizobia annually record 16.4 million tons of nitrogen. Moreover, its share in plants may vary from 0 to 95% depending on the conditions of nitrogen fixation, where the level of available mineral nitrogen is crucial (Herridge, et al. 2008). In the US, soybean is mainly cultivated on soils with a high content of available nitrogen, primarily due to the introduction of a large amount of fertilizer. The efficiency of nitrogen fixation decreases and varies from 40 to 80%, averaging 58% (Russell et al. 2004). In Brazil, it is grown on soils with a low content of available nitrogen and without nitrogen fertilizers, so the proportion of this element obtained by nitrogen fixation is about 80% (Alves, et al. 2003). Thus, it should be noted that the use of agropriem - inoculation of seeds

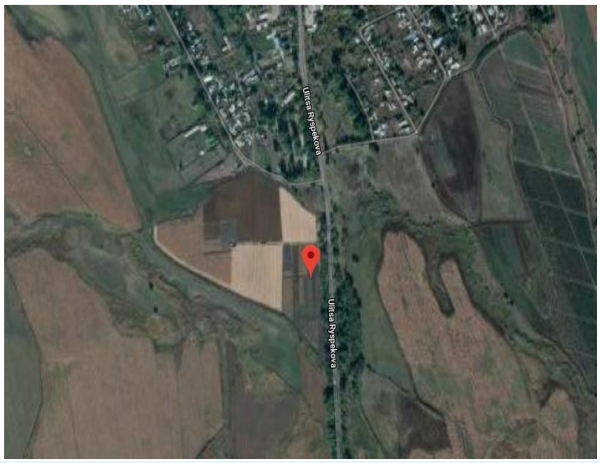

Fig. 1. The location of the UOS “AgroUniversity”

Fig. 2. Bookmark the field experience

with nitragin and in the conditions of our study, allows significantly increase the symbiotic nitrogen fixation of soy, which makes it possible to reduce the dose of mineral fertilizers and reduce the cost of cultivation with a subsequent increase in soil fertility and crop productivity. In solving such very urgent problems of increasing fertility soil and crop productivity in southeastern Kazakhstan.

The effectiveness of bioecological - nitrogen-fixing features of the culture itself was studied against the background of resource-saving techniques of soybean cultivation technology. At the present stage of work related to the study of the effectiveness of inoculation of soybean seeds, as well as the accumulation of nitrogen in the total biomass of plants and soil, it is insignificant and is very important, since it is aimed at finding new opportunities for greening agriculture and increasing soil fertility.

Materials and Research Methods

Experimental studies were carried out at the training experimental station, UOS “Agrouniversitet”, located on the plain of the northern slope of Zailiysky Alatau (altitude 550-700 m above sea level). The area, the village of Saimasay, Enbekshikazakh district, Almaty region, where the field experience is laid (**Fig. 1**). characterized by an extreme sharply continental climate, short but cold winters, a long period of high air temperatures, plenty of sunlight in the warm season, intense evaporation of moisture, and low humidity (Alisheva 2006). The experiment was carried out on meadow-chestnut soils of heavy mechanical composition, characteristic of the foothill zones of the Tien Shan mountains (**Figs. 2** and **3**).

Climatic Conditions during the Years of Research

The territory of the AgroUniversity University training station is characterized by a sharply continental climate with large daily and annual fluctuations in air temperature with an average daily air temperature of 7.7 ° C and an unequal amount of precipitation - from 415 mm (Almaty, Airport).

The main feature of the zone during the years of study is the maximum amount of precipitation in the spring (March-April) and the minimum in the summer (July-August). The temperature regime of air was characterized by a relatively elevated temperature in all periods. In 2015, the average annual air temperature was 11.40 C, which is 3.30 C, in 2016 - 2.20 C and in 2017 - 3.10 C higher (**Fig. 4**).

An important climate factor that determines the growth and development of plants is the amount of precipitation and their distribution by season (**Fig. 5**).

A distinctive feature in the years of research is the loss of a large amount of precipitation in the early spring, which significantly exceeds the average long-term

Fig. 3. The field experience

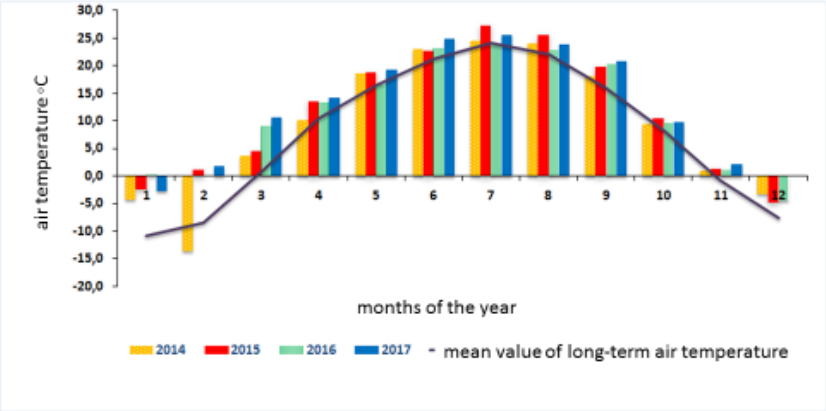

Fig. 4. Average monthly temperature values (t°C) in the years of research

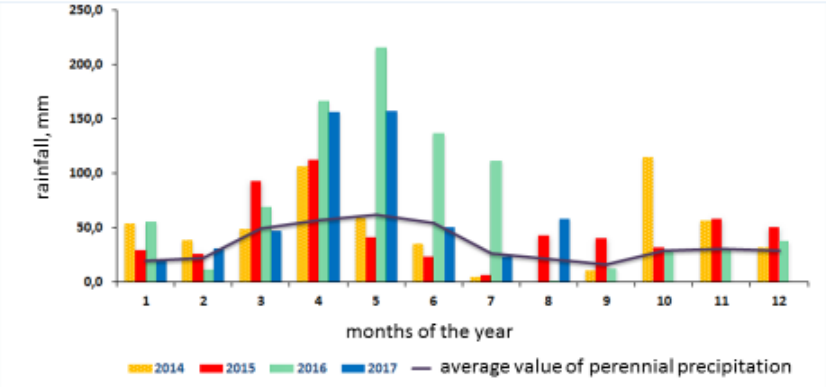

Fig. 5. Average monthly precipitation values (mm) in years of research

height. So, the amount of precipitation in November and December 2015 is two times higher than the annual average. In 2016, in the winter-spring period, the height of precipitation also exceeded the average annual norm, especially in April, exceeded three times, and in May - 3.7 times, when 166.6 mm and 216.2 mm respectively fell with average annual norms (56.5 and 66.6 mm). This situation of rainfall distribution in the spring had a double effect on the vegetation of the studied crops - on the one hand, due to frequent rains, the sowing period of the studied crops was extended, on the other hand, less vegetation irrigation was carried out.

Thus, the analysis of weather and climate conditions over the years of research in comparison with long-term data shows that the climate is characterized by a high temperature regime and the level of rainfall during the growing season over the years. The sowing season and the initial vegetative period of soybeans formed a favorable water and temperature regime of the soil, and were provided optimal conditions for a friendly and full germination of culture (Anaeto et al. 2017, Mukhtar et al. 2018).

Sampling and Soil Analysis

Field experiments were based on meadow-chestnut soils, heavy mechanical composition, which are characteristic types of the foothill strip of South-East Kazakhstan. The soil of the study area is slightly alkaline with a pH of 7.3 in 1: 1 (weight / volume), while the amount of their average $CaCO_3$ is about 5.8%. In addition, the organic matter content, C/N ratio and total mineral nitrogen (NH_4 + NO_3), available phosphorus and available potassium on the soil surface are 4.45%, 11.8, 87 mg / kg, 435.1 mg / kg and 22 mg. / kg respectively Rowell (1994); Jones Jr. (2001) and Suleimenova (2019).

The object of study are soybeans (Eureka variety) and crop rotation of fruit-bearing crops. Studies were carried out in accordance with the scheme.

Experimental studies were carried out by generally accepted classical methods: experiment and observation of Armor (1985); Novikova A.M., Novikova D.A. (2010).

As a control in the experiments, we used the traditional technology of soybean cultivation in accordance with the recommendations of the “Almaty Agricultural System (2005).”

As part of our research, we have tested:

1- factor, A - methods of resource-saving technology;

2- factor, B - with two options for applying mineral fertilizers -

- $P_{60}K_{30}$ and - $N_{30}P_{60}K_{30}$ and the effect of soybean seed treatment with nitragin to establish the effect of the studied options for the norms of mineral fertilizers and inoculation on the activity of nodule formation;

Table 1. Scheme of the full factorial experiment, FFE (2x3x3)

I-factor - Soybean cultivation technology - **A**		Factor II - Use of fertilizers and inoculation of soybean seeds - **B**	III factor - Soybean sowing rates - **C**
A_1 - Traditional technology with dump processing - Plowing at depth 20-22 cm, control-St		No fert. - **B_1**	**C_1** - 400 thousand units/ha -St **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
		Nitragin - **B_2**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
		$N_{60}P_{180}K_{90}$ - **B_3**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
A_2 - Resource saving technology	Resource-saving (Mini-Till) technology with flat-cutting processing on the depth 16-18 cm	Nitragin - **B_1**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
		$P_{60}K_{30}$ - **B_2**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha a **C_3** - 800 thousand units/ha
		$N_{30}P_{60}$ K_{30} - **B_3**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
	Resource-saving (Mini-Till) technology with flat-cutting processing on the depth 12-14 cm.	Nitragin - **B_1**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
		$P_{60}K_{30}$ - **B_2**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha
		$N_{30}P_{60}$ K_{30} - **B_3**	**C_1** - 400 thousand units/ha **C_2** - 600 thousand units/ha **C_3** - 800 thousand units/ha

3-factor, C - determination of the optimal seeding rate, 3 seeding rates of 400, 600 and 800 thousand units / ha were studied with a row spacing of 30 cm.

The experiment was laid on a full three-factor scheme matrix. The size of the experimental plot is 42.0 m 2 = (10.0 m x 4.2 m), the recorded plot area is 21.6 m 2 = (6.0 m x 3.6 m). Three repetitions. Placement of options by split plots. Sowing was carried out in the 2nd decade in the month of May.

In pursuit of the research goal, the following observations, definitions, and censuses were carried out: Soil agrophysical indicators were determined — soil density was determined by volumetric mass using the Kachinsky and Savinov method (1975); - the aggregate composition of the soil in 0-10, 10-20, 20-30cm of the soil layer by dry sieving method according to N. I. Savinov; - soil structural coefficient (by calculation) and - water strength of soil aggregates in 3-fold repetition according to the method of N. I. Savinov in the modification of the Agrophysical Institute).

Agrochemical studies to determine the nutritional regime of the soil (GOST 17.4.4.02.) Included several mandatory procedures: - sampling, - preparation of samples for analysis, - determination of the content of mobile forms of nitrate nitrogen and phosphorus Eleshev (2014), the Photoelectrocolorimeter - FEK-KFK was used -2CHA- 4.2. Nitrate and ammonia nitrogen was determined on a Skalar automatic analyzer (GOST 26488-85 and GOST 26489-85); mobile phosphorus was determined by B. P. Machigin. (GOST 26205-91).

Biometric and phenological observations on soybean crops were carried out in accordance with the recommendations of the Institute for Field and Vegetable Production, and the GOS Methodology of agricultural crops - for growing grain, leguminous and oilseeds; Cleaning was carried out manually and mechanically. Plants were mowed at a plant height of 10-12 cm Lukomce (2007). The soybean crop was taken into account from the plot area in the phase of full ripeness of grain. Statistical processing of the research results was carried out at the KazNAU EC using methods of processing the data of quantitative variability, correlation-regression and analysis of variance according to Dospekhov (1985) and Dziuba, Shchemelev (2004).

RESULTS AND DISCUSSION

As part of our research, we have tested the techniques of resource-saving technology with two options for applying mineral fertilizers - $P_{60}K_{30}$ and N_{30} P_{60} K_{30} and the effect of processing soybean seeds Rizovit-AKS - nitragin. To establish their influence on the activity of nodule formation. We have studied 3 seeding rates of 400, 600 and 800 thousand units / ha. In a comparative assessment of the studied norms of mineral fertilizers, inoculation and the seeding rate for control - St accept sowing according to traditional technology without fertilizers.

Effective methods have been identified to justify the role of the biological and environmental features of soy in increasing the fertility of chestnut soils. They were agrotechnical methods, such as seed inoculation and the starting dose (($P_{60}K_{30}$) of fertilizers against the background of resource-saving methods of soil cultivation, which have a huge impact on the activity of microorganisms and soil aeration of the root zone.

The main indicator of the effectiveness of the symbiosis of plants and nodule bacteria is their number and mass. With traditional technology, in the studied variants of the seeding rate without inoculation, very few nodules were formed on soybean roots in the range of 9.7 and 12.4 pieces per soybean plant (**Table 2**).

The absence of seed inoculation leads to a weak formation of nodules and a decrease in the amount of fixed nitrogen. With inoculation of soybean seeds with nitragin, the number of nodules increases and, depending on the seeding rate, range from 16.2 to 21.0 pieces per plant, and the weight of nodules is 72.9 -97.9 mg / plant. With this technology, the recommended doses of mineral fertilizers ($N_{60}P_{180}K_{90}$) for the study zone [14] have a significant effect on the amount of formation of nitrogen-fixing nodules and are in the range of 27.7 and 29.5 pcs / 1 rst., and the mass of dry nodules is 124.6-137.1 mg / rast.

In the experiment, when studying the effect of soil cultivation, the biological nitrogen fixation was higher

Table 2. Effect of mineral fertilizers with inoculation and seeding rates for nodules of nitrogen-fixing soy bacteria (over the years of research)

Technology		Fertilizer applications	The number of nodules, pcs / plants.			Weight of nodules, mg/plants.		
			400 thousand pcs/ha	600 thousand pcs/ha	800 thousand pcs / ha	400 thousand pcs/ha	600 thousand pcs/ha	800 thousand pcs/h
Traditional		Without fertilizers	9.7	12.4	11.6	42.0	57.7	55.1
		Nitragin	16.2	21.0	19.7	72.9	97.9	93.6
		$N_{60}P_{180}K_{90}$	27.7	29.5	27.4	124.6	137.1	130.1
Resource-saving	Mini-till, depth. 16-18 cm	Nitragin	24.5	29.1	26.7	110.2	135.3	125.5
		$P_{60}K_{30}$	35.1	38.0	36.3	152.5	175.8	170.6
		$N_{30}P_{60}K_{30}$	39.4	47.6	45.9	177.3	221.3	252.0
	Mini-till, depth. 12-14 cm	Nitragin	28.2	30.5	24.9	126.9	151.9	118.8
		$P_{60}K_{30}$	33.9	37.8	30.3	157.9	176.4	143.3
		$N_{30}P_{60}K_{30}$	35.8	39.1	32.5	161.0	181.8	152.7

Table 3. Soybean productivity depending on the use of mineral fertilizers with inoculation in the years of research, c/ha

Technology		Fertilizer applications	Yield in years of research, dt/ha			Average yield, dt/ha	Increase in	
			2015	2016	2017		dt/ha	%
Traditional		Without fertilizers	18.1	20.0	21.2	19.8	St	-
		Nitragin	18.9	23.1	23.8	21.9	2,1	10,6
		$N_{60}P_{180}K_{90}$	23.0	26.8	28.2	26.0	6.2	31.3
Resource-saving	Mini-till, technology with flat-cutting processing on the depth 16-18 cm	Nitragin	22.0	22.4	23.7	22.7	2.9	14.6
		$P_{60}K_{30}$	23.7	28.7	27.1	26.5	6.7	33.8
		$N_{30}P_{60}K_{30}$	24.3	28.9	27.5	26.9	7.1	35.8
	Mini-till, technology with flat-cutting processing on the depth 12-14 cm	Nitragin	23.5	24.6	23.9	24.0	4.2	21.2
		$P_{60}K_{30}$	26.8	26.1	27.2	26.7	6.9	30.7
		$N_{30}P_{60}K_{30}$	27.2	24.3	27.4	26.3	6.5	32.8
HCP_{05}, dt/ha =			1.85	2.15	2.3			
S_x, % =			2.75	3.06	3.87			

with minimal planar soil cultivation. Against the background of resource-saving technology, inoculation of seeds with nitragin has a significant positive effect on the formation of nodules where, their number increases to 24.5-29.1 pcs / 1rast, depending on the rate of seeding. Against the background of applying P60K30, the number of nodules rises to 35.1-38.0, and with the application of $N_{60}P_{180}K_{90}$ fertilizers this pattern dependence of the formation of nodules, is maintained and is -39.4-47.6 pcs / 1rast (against the background of resource-saving Mini-till). In this case, the mass of nodules increases in the same sequence as the number of nodules in the variants. The introduction of mineral fertilizers in a dose of P60K30 was the main and optimal background for the use of the inoculator, therefore, the possibility of nodule formation on the roots of soy plants increased by 1.31-1.43 times, and the use of $N_{60}P_{180}K_{90}$ by 1.08 - 1.33 times. A comparative assessment of the biological nitrogen fixation of soy in the root layer of the soil, with resource-saving technology, indicates the highest number of nodule formation on soybean roots - up to 47.6 pcs / year. with a maximum weight of up to 221.3 mg / 1 rst. at a seeding rate of 600 thousand units / ha. Inoculation of soybean seeds with an optimal background of application of $P_{60}K_{30}$ provides better fixation of nitrogen and a positive nitrogen balance of the soil under the conditions of using the Mini-till soil treatment system.

Thus, with a combination of inoculation and the application of phosphorus and potassium fertilizers ($P_{60}K_{30}$) against the background of minimal (Mini-Till) soil cultivation, resource-saving soybean cultivation technology ensures the conservation and restoration of soil fertility. This can be explained with two main factors. Firstly, the minimal flat-tillage creates optimal composition of the arable soil layer with optimal density, where the root system of plants Suleimenova, et al., (2019) abundantly grows. Secondly, soybean captures a large amount of atmospheric nitrogen in symbiosis with Bradyrhizobium. A significant part of it is used by growing soybean plants, and a certain part remains in the nodules and in the soil unused. After soybean harvesting, these root residues and unused nitrogen remain in the soil, and optimize agrochemical indicators of effective soil fertility.

The results of a structural sheaf analysis of soybean productivity, when studying traditional technology without fertilizers, is only 19.8 c / ha. When studying the effect of inoculation of soybean seeds in combination with the optimal norm of mineral fertilizers on increasing soil fertility and crop productivity, it was revealed that when processing soybean seeds before sowing with nitragin, the yield increases to 22.7 c / ha (**Table 3**).

The combined use of mineral fertilizers and inoculation with resource-saving technology (Mini-Till) creates favorable conditions for the synthesis and accumulation of biomass in plants. Moreover, the greatest effect is observed with inoculation with the introduction of mineral fertilizers at a dose of $P_{60}K_{30}$. The

yield increase from the use of mineral fertilizers with inoculation is 6.7-7.9 kg / ha (at a dose of $P_{60}K_{30}$).

As a result of the structural-sheaf analysis of soybean productivity, the ratio of roots to the aerial part of the biomass is 1: 3, where the yield upon inoculation is 22.7 c / ha. Grain yield at a percentage of the mass of the crop to the total mass of plants is 0.33, as a rule, this gives 46.1ts / ha of root biomass in the soil. And another 10 kg / ha of biomass in the form of fallen leaves.

The formation of a large number of root and crop residues (56.1c / ha) of organic matter by soy, which is growing for more than three months, undoubtedly has a positive effect on increasing soil fertility. In addition, soybean makes it possible to reduce up to 50% the amount of nitrogen fertilizers needed for subsequent crops. Therefore, after soybean, only half the rate of nitrogen fertilizer required for the subsequent crop rotation is required, since soybean gives the equivalent of 150 kg / ha of nitrogen fertilizer. Thus, the techniques of resource-saving technology, such as the application of mineral fertilizers at a dose of $P_{60}K_{30}$ in combination with seed inoculation based on the ecobiological features of soybeans, are one of the ways to increase crop productivity and soil fertility.

CONCLUSION

The techniques of resource-saving technology and the application of mineral fertilizers in a dose of $P_{60}K_{30}$ in combination with seed inoculation, based on the ecobiological features of soybeans, is one of the ways to increase crop productivity and soil fertility.

Inoculation of soybean seeds with Rizovit-AKS - nitragin increases the number and dry weight of symbiotic nitrogen-fixing nodules with a subsequent increase in soybean yield. The effect is further enhanced by the combination of inoculation and the application of phosphorus and potassium fertilizers against the background of minimal (Mini-Till) tillage. Fertilizing in a dose of $P_{60}K_{30}$ forms the largest number of nitrogen-fixing bacteria (up to 47.6 pcs / 1rast) with a higher dry weight up to 221.3 g / 1rast. Namely, against this background, the potential productivity of the soybean culture itself increases from 19.8 c / ha to 26.9 c / ha.

The combination of inoculation and the application of phosphorus and potassium fertilizers ($P_{60}K_{30}$) against the background of minimal (Mini-Till) soil cultivation in resource-saving soybean cultivation technology ensures the conservation and restoration of agrophysical indicators of soil fertility. Soy plants record a large amount of atmospheric nitrogen, where up to 60% is used by growing soy and more than 35-40% accumulates in the soil. After harvesting, root residues enrich the soil and optimize the agrochemical factors of soil fertility.

The obtained research results prove that the application of mineral fertilizers in a dose of $P_{60}K_{30}$ in combination with seed inoculation, based on the eco-biological features of soybeans, is one of the ways to increase crop productivity and soil fertility.

REFERENCES

Alisheva K (2006) Natural resources of Kazakhstan, their use and protection. Soil resources and their protection. Ecology - Almaty HAS: 64-105.

Alves BJR, Boddey RM, Urquiaga S (2003) The success of BNF in soybean in Brazil. Plant Soil 252: 1-9.

Anaeto FC, Uke PC, Korie OC, Ohajianya DO (2017) A Tobit Analysis of Propensity to Discontinue Adoption of Yam Minisett Technology among Farmers in Anambra State, Nigeria. International Journal, 4(3): 58-62.

Armor BA (1985) Field experiment technique. Agropromizdat -351 s.

Beloborova SN (2012) The productivity of common beans (Phaseolus vulgaris L.) when treating seeds with microbial preparations. abstract of the dissertation for the competition. degrees of c.-. - St. Petersburg: 19 p

Demidenko ES, Dergacheva EA (2010) Technogenic development of society and transformation of the biosphere. KRASAND: 187 p.

Dozorov AV, Ermoshkin YuV (2007) Symbiotic and photosynthetic activity of soybeans for different periods and methods of sowing. Grain farming 6: 30-32.

Dzyuba VA, Shchemelev BN (2004) Planning of multivariate experiments and methods of statistical processing, experimental data. Guidelines. - Krasnodar: 83 p.

Eleshev RE et al. (2014) Workshop on agrochemistry. - Almaty: - 264 p.

Ghosh A, Singh AB, Kumar RV et al. (2020) Soil enzymes and microbial elemental stoichiometry as bio-indicators of soil quality in diverse cropping systems and nutrient management practices of Indian Vertisols. Applied soil Ecology.145. UNSP 103304.

Herridge DF, Peoples MB, Boddey RM (2008) Global inputs of biological nitrogen fixation in agricultural systems. Plant and Soil 311: 1-18.

Holmes AA, Thompson AA et al. (2019) Nitrogen provisioned and recycled by cover crops in monoculture and mixture across two organic farms. Nutrient cycling in agroecosystems 115(3): 441-453.

Hu Y, Jiao J et al. (2018) Evidence for Phosphate Starvation of Rhizobia without Terminal Differentiation in Legume Nodules. Molecular plant-microbe interactions 31(10): 1060-1068

John Beddington (2011) The Future of Food and Agriculture: Goals and Alternatives to Global Sustainable Development. Foresight Overview.

Jones BJJ (2001) Laboratory guide for conducting soil tests and plant analysis. CRC Press. New York, USA.

Kachinsky, Savvinov NI (1975) Methodology for determining the aggregate composition and water resistance of the soil by the method of Kachinsky and N.I. Savvinov Workshop on agriculture Vorobyov S.

Kaledin AP, Abdullah-Zade EG, Dezhkin VV (2011) Environmental and economic problems of the agro-industrial complex, Environmental and economic aspects of modern nature management. MGOOiR: S.157-166

Kokorina AL, Kozhemyakov AP (2010) Bean-rhizobial symbiosis and the use of microbiological preparations of complex action - an important reserve for increasing the productivity of arable land. - St. Petersburg, 50s.

Kuryata VG, Golunova LA, et al. (2018) Peculiarities of the formation and functioning of soybean-rhizobial complexes and the productivity of soybean culture under the influence of retardant of paclobutrazol. Ukrainian Journal of Ecology 8(3): 98-105

Lukomets (2007) Methodology for conducting field agrotechnical experiments with oilseeds / Ed. V.M. Lukomets. - Krasnodar: VNIIMK: - 112 p.

Mania D, Woliy K et al. (2019) A common mechanism for efficient N2O reduction in diverse isolates of nodule-forming bradyrhizobia. Environmental Microbiology. https://doi.org/10.1111/1462-2920.14731

Mirkin BM, Naumova LG (2005) Conversations on the sustainability of ecosystems. Ecology and life 2: 33-37.

Mukhtar F, Chisti H (2018) The Study of Heavy Metals in Sediments Sampled from Dal Lake. Journal of Environmental Treatment Techniques, 6(2): 33-35.

Novikova AM, Novikova DA (2010) Methodology of scientific research. Librocom. 280 p.

Patika VP, Panchenko GM, et al. (2001) Agricultural Microbiology to Help Agricultural Production. Collection of scientific developments. - Chernihiv: 57 p.

Penchukov VM, Medyanikov NV, Kaplushev AU (1984) Culture of great opportunities. Stavropol: 286 p.

Rowell D (1994) Soil Science: Methods and Applications. Longman Group UK Limited, UK. 350p.

Russell MP, Birr AS (2004) Large-scale assessment of symbiotic dinitrogen fixation by crops: soybean and alfalfa in the Mississipi River basin. Agron J 96: 1754-1760.

Smekalov PV, Omarova NYu (2011) Global trends and priority areas of agricultural development at the beginning of the XXI century. Zh.Ekonomika regiona 1: 11-21

Soils. Determination of mobile compounds of phosphorus and potassium by Machigin method modified by CINAO (GOST 26205-91).

Stakhurlova LD, Stulin AF, Gromovik AI (2015) Productivity of maize in conditions of prolonged use of various agrotechnical techniques on leached chernozems. Bulletin of the Voronezh State University, Series: Chemistry, Biology, Pharmacy 2: 92-95.

Suleimenova N, Makhamedova B et al. (2019) Efficiency of resource-saving technology of rape agroecosystem (brassica napus) in the foothill zone of southeastern Kazakhstan Eurasian Journal of Soil Scitnce 8(1): 83-93.

The agricultural system of Almaty region (2005) - Recommendations - Almaty: Nurly Alem LLP -296s.

The Future of Food and Farming (2011) Executive Summary. The Government Offi ce for Science, London, 44 s.

Tufa AH, Alene AD et al. (2019) The productivity and income effects of adoption of improved soybean varieties and agronomic practices in Malawi// World development 124: 104631

Wang P, Marsh EL (2017) Shifts in microbial communities in soil, rhizosphere and roots of two major crop systems under elevated CO2 and O-3. Scientific reports 7: 15019. https://doi.org/10.1038/s41598-017-14936-2

Zhao R, Liu LX et al. (2018) Adaptive evolution of rhizobial symbiotic compatibility mediated by co-evolved insertion sequences. Isme Journal 12(1): 101-111.