Effect of mineral and organic fertilizers on the Soybean *(Glycine max)* yield and fertility of the irrigated soils

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Abstract. The researches were carried out during a number of years (2006-2008, 2012-2013) on the chestnut-like meadow soils at "Agrouniversitet" instructional farm. The plowing layer of the experimental plot's soil contains 4.38% of humus substance, the volume of which tend to decrease gradually as it gets deeper. The contents of total nitrogen are 0.221%, phosphor – 0.190% and total potassium – 2.5%. Thus, results of our researches showed that mineral and organic fertilizers are the efficient factor with regards to the resource saving technology used to cultivate promising leguminous crops, which substantially increase the yielding capacity and gross harvest of seeds subject to diversification of crop science in the south-east of Kazakhstan.
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Introduction

Soybean *(Glycine max)* is a leguminous vegetable of the pea family that grows in tropical, subtropical, and temperate climates. It consists of more than 36% protein, 30% carbohydrates, and excellent amounts of dietary fiber, vitamins, and minerals. It also consists of 20% oil, which makes it the most important crop for producing edible oil.

There is an important economic and scientific value of study on soybean genome. First, soybean is one of the most important crops for producing protein and oil. Second, it has the capacity to fix nitrogen which is one of the major problems of life science. Biological nitrogen fixation provides all the plants with 75% of nitrogen, which plays an important work in the practical production [1]. At present soybeans are planted in more than 80 countries of the world. There are large plantations of soybean in China, Brazil, Korea, Japan, Vietnam, Argentine, Mexico, Canada, Iran, Nigeria, Australia and many other countries. The USA is the largest soybean seeds in the world, where this crop is grown in 30 states [2, 3, 4, 5]. World soybean production in 2012-2013 was 267.5 million tons [6]. Of all Central Asian countries, Kazakhstan is the one in which the soybean is the most important as a commercial crop – by far. They probably have at least several thousand hectares planted to soybeans. The soybeans in Kazakhstan are run through an extruder (extrusion cooker) to make soybean oil and meal. These same extruders are also used to process cotton seed. Soybeans are grown in Central Asia largely because of the demand for meal by the local poultry industry for use in chicken feeds. Poultry is the driving force, and Central Asia is a "protein – poor" region. Walters's main reason for being there is because of poultry and (to a lesser extent) livestock; it is to help educate them about the soybean, its value for producing soybean meal and oil, and about the importance of protein. He helps farmers to grow soybeans and to develop markets for their beans. Actually, there is a ready – made market from poultry growers – who now have to pay a lot of freight to import their soybeans from Kazakhstan, Iran, Turkey or India. The key is for Walter to serve as the bridge – to help bring the poultry growers and the potential soybean farmers together, to discover that they have a common interest, and then to work out agreements [7]. Planted area of soybean in Kazakhstan was 84500 ha in 2012 year. In 2012 year Kazakhstan produced 169800 tons and grain yield of soybean was 20095 kg/ha [8]. Due to the diversification of crop science, the structure of cropland acres under agricultural crops in the country undergoes substantial changes almost in all regions. So, according to the information of the Agriculture Ministry of the Republic of Kazakhstan, in the coming years the country plans to increase the soybean planting up to 200 thousand hectares. In recent years, due to the deterioration of the ecological situation the issue of development of the biological farming tends to become increasingly urgent. One of the important factors of it is the system of application of fertilizers and in particular, a source of nitrogen being alternative to the mineral one. In the world practice, bean cultures are widely used for this purpose, as they take up nitrogen from the atmospheric air. The efficiency of the nitrogen mobilization grows in case of inoculation of the seeds.

A.P.Kozhemyakov, L.M.Dorosinsky [9] observed that in the West European and North American countries this approach is used for 60-100% bean culture plantings. E.V.Agafonov et al. [10] noted that the cropping power of soybeans rises both by adding NPK, and bacterial fertilizers. Such a wide spread of the soybean is due to a number of its properties, which make its planting environmentally and economically profitable.

It should be noted that during many researches, the role of the inoculation is brought to assessment using the cropping power of the plants and in fact fails to reflect the role of precursors, types of soil, varietal features, various fertilizer elements, organic fertilizers etc. Therefore the issue related to examination of the effects of macro and microelements, as well as various types of organic fertilizers on the soil feeding schedule and cropping power bean cultures, in particular, soybean, appears to be topical. Our researches are devoted to this important issue. They are aimed to study the effect of fertilizers on the symbiotic activity and cropping power of soybeans in conditions of the piedmont area of Almaty.

Material and methods

The field experiments were carried out within the territory of the “Agrouniversitet” experimental and instructional farm of the Kazakh National Agricultural University, located in the piedmont even land on the northern slope of the Zailiyskiy Alatau, on old irrigated carbonate chestnut-like meadow soils, at the permanent study area of the Department “Soil science, agro chemistry and ecology”, in the north – western part of Yenbekshi – Kazakh area, Almaty region, 37 km of Almaty and 18 km of Issyk. The site lies at longitude 43°28′59.93′ ′C and latitude 77°19′16.03′′B. The climate of the study area is characterized as strongly continental with an average annual rainfall of 350-420 mm. The soils at the study site were a meadow chestnut soil with pH=7, organic matter, total phosphorus, and total nitrogen contents of 4.38, 0.211, and 0.258%, respectively.

The field experience in 2006-2008 was gained in the 4 – field crop farming rotation, evolving in the space and time: 1 – soybean; 2 – rapeseeds; 3 – spring barley; 4 – carthamus. The two low to ensure availability of labile phosphor were created in advance – natural low P_0 containing 18-20 mg of P_2O_5 per 1 kg of soil and artificial high P_{150} (with preliminary addition of 150 kg of the active substance of phosphor fertilizers) containing 35-40 mg of labile phosphor per 1 kg of soil at the beginning of researches. Against these low, the following scheme of addition of the fertilizers was used for the soybeans: Low P_0 – Control without fertilizers – seeds that had been treated with nitragin, Control without fertilizers seeds that had been treated with nitragin, N_{30} – seeds that had not been treated with nitragin, N_{30} – seeds treated with nitragin, P_{60} – seeds treated with nitragin, P_{60} + M_0 – seeds treated with nitragin, K_{60} – seeds treated with nitragin, K_{60} + M_0 + C_0 – seeds treated with nitragin. High P_{150} – Control without fertilizers – seeds that had been treated with nitragin, Control without fertilizers seeds that had been treated with nitragin, N_{30} – seeds that had not been treated with nitragin, N_{30} – seeds treated with nitragin, P_{60}-seeds treated with nitragin, P_{60} + M_0 – seeds treated with nitragin, K_{60} – seeds treated with nitragin, K_{60} + M_0 + C_0 – seeds treated with nitragin.

In 2012-2013, the experiments were also carried out in the 4 – field farming rotation with the following crops: 1 – spring barley, 2 – oil flax, 3 – spring rapeseeds, and 4 – soybean. During the experiments, the following scheme of the soybean fertilizers was studied: In 2012: 1 – Control (without fertilizers); 2 – Recommended PK ($P_{80}K_{25}$) rate; 3 – Recommended ($P_{80}K_{25}$) rate + microelements (Mo, Co, Zn); 4 – Recommended ($P_{80}K_{25}$) rate + Mo; 5 – Recommended ($P_{80}K_{25}$) rate + Co; 6 – Recommended ($P_{80}K_{25}$) rate + Zn; 7 – Cow dung (45 t/ha) – effect; 8 – Cow dung (30 t/ha) – effect; 9 – Vermicompost (6.0 t/ha) – effect; 10 – Vermicompost (3.0 t/ha) – effect; 11 – Straw (6.0 t/ha) – effect; 12 – Straw (6.0 t/ha) – effect + cow dung (30 t/ha); 13 – Cow dung 30 t/ha – effect; 14 – Microelements (Mo, Co, Zn) effect. In 2013: 1 – Control (without fertilizers); 2 – Recommended PK ($P_{70}K_{20}$) rate; 3 – Recommended rate ($P_{70}K_{20}$) + after effect of the microelements (Mo, Co, Zn); 4 – Recommended rate ($P_{70}K_{20}$) + after effect of Mo; 5 – Recommended rate ($P_{70}K_{20}$) + after – effect of Co; 6 – Recommended rate ($P_{70}K_{20}$) + after effect Zn; 7 – Cow dung (45 t/ha) – after effect; 8 – Cow dung (30 t/ha) – after effect; 9 – Vermicompost (6.0 t/ha) – after effect; 10 – Vermicompost (3.0 t/ha) – after effect; 11 – Straw (6.0 t/ha) – after effect; 12 – Straw (6.0 t/ha) – after effect + cow dung (30 t/ha); 13 – Cow dung – 30 t/ha – after effect; 14 – Microelements (Mo, Co, Zn) after effect.

The area of experimental plot is 60 m^2 (4x15m); the experiment was repeated thrice. The soybeans were sown within the period being optimal for the area, subject to the recommended seeding rate, depth of the seeding – down and feeding area (planting width is 70 cm). The following fertilizers were used: nitrogen – ammonium saltpeter containing 34% of N; standard phosphor – superphosphate contains 19% of P_2O_5 and potassium – chloride potassium containing 50% of K_2O. The organic fertilizers were semi – weathered cow dung, vermicompost (product of vermicultures, and straw of grain crops. The cow dung is a fertilizer generated during operation of biogaseous units using the cow dung and different wastes, which are recently widely used. The agrotechnics used in the experiments was as advised for the area. The method used in the researches was generally accepted in agro chemistry and crop science. Moisture content of soil during the experiments was 60-70% of nominal humidity and it was maintained by 3-4 wettings with the water application rate equal to 800 – 850 m^3/ha, subject to precipitations. During the vegetation period of the crops with regards to the key growth and development phases, soil and plant samples were taken at the depth of 0-20, 20-40 cm. The harvest was recorded for each plot separately. The following elements were found out in the soil samples: 1 – gross forms of nitrogen, phosphor, potassium from a single sample weight according to Ginzburg and Scheglova's method with further determination of nitrogen using the Kjeldahl method [11]; phosphor – using the colorimetric method, potassium using the flame spectrophotometer; 2 – labile forms of N, P, K – nitrate nitrogen ($N – NO_3$) using the Grandval – Lyaugou method, ammoniac nitrogen using the Nessler reagent, labile phosphor and exchange potassium – using the 1% – coal ammoniacal exudate under B.A. Machigin method [11]; 3 – humus substance using I.V. Tyurin method [11]. In the plant samples, the following factors were found out: 1 – dynamics of accumulation of the wet and dry solid matter; 2 – content of NPK in the main and byproduct at the beginning and in the end of vegetation – by a single sample weight after wet digestion under Ginzburg and Scheglova (nitrogen – under the Kjeldahl method, phosphor – using colorimetric potassium method with a flame spectrophotometer); 3 – contents of crude fat under the Soxhlet method [11].

Results and discussion

When creating the artificial phosphor high (P_{150}), contents of labile phosphor grew up to 35 – 39.6 mg/kg of soil (within the plowing layer) with fluctuations in different fields under farming rotation and continuous reduction in the following years (Table 1). The harvest recording, which was carried out for each separate plot, subject to determination of accuracy under B.A. Dospehov's method [12] showed that the value of yielding capacity of the soybeans varied widely depending on feeding conditions. Since prior to seeding, soybean seeds were treated with nitragin, the low dose of the nitrogen fertilizer against the law P_0 (15 – 20 mg of P_2O_5) (N_{30}) did not have any substantial effect on the yielding capacity and the additional surplus in the harvest amounted only to 0.17 t/ha. Almost the same surplus was gained by adding K_{60} (0.24 t/ha) under ploughing, whereas the yielding capacity was controlled at the level of 1.96 t/ha.

Table 1. The yielding capacity of soybean depending on factors under consideration, in t/ha (average amount for the 3 years)

Experiment option	Low – P_0		High – P_{150}	
	Harvest, (t/ha)	Surplus, t/ha	Harvest, t/ha	Surplus, t/ha
Control without fertilizers, seeds were not treated with nitragin	1.96	–	2.49	–
Control without fertile zers, seeds treated with nitragin	2.26	0.30	2.66	0.17
N_{30}, seeds were not treated with nitragin	2.16	0.20	2.62	0.13
N_{30}, seeds treated with nitragin	2.33	0.47	2.75	0.26
P_{60}, seeds treated with nitragin	2.59	0.63	2.79	0.30
$P_{60}+M_0$, seeds treated with nitragin	2.80	0.84	3.01	0.52
K_{60}, seeds treated with nitragin	2.20	0.24	2.72	0.23
$K_{60}+M_0+C_0$, seeds treated with nitragin	2.49	0.53	3.09	0.60
LSD 0.17–0.24				

Against high P_{150} (35 – 40 mg of P_2O_5 per kg of soil), the yielding capacity of soybean was 2.49 t/ha, i.e. was 0.53 t/ha higher than against the natural (P_0) low. When adding N_{30} against this low, the harvest changed insignificantly (surplus was 0.13 t/ha), whereas during addition of $K_{60,}$ the surplus in the harvest was the same as against the natural low (0.23 t/ha). Soybean positively responded to the addition of phosphor fertilizers (P_{60}), especially against the high of low content of labile phosphor in the soil, thus ensuring the 0.63 t/ha surplus in the harvest. But even against the high content of labile phosphor in the soil, the phosphor fertilizers (P_{60}) ensured a noticeable surplus in the grain harvest (by 0.30 t/ha). As to the option involving joint addition of the phosphor fertilizer and molybdenum microelement (the latter was added at the rate of 1.5 kg/ha) (P_{60}+Mo), the yielding capacity of soybean was 2.80 t/ha, i.e. the surplus amounted to 0.84 t/ha, and in case of application of Mo, which had a material effect on the symbiotic activity, which became apparent from the quantity, weight and quality of knobs in one of the options, it ensured the additional 0.21 t/ha surplus in the grain harvest.

It is known that the problem related to soil fertility management has become currently more complicated (Table 2). The modern concept of optimization of the organic substance regime in cultivated lands involves such a structure of the farming systems when the reproduction of humus substance in the soils would require as low special and labor – intensive costs as possible. From this point of view, the modern short farming rotations require considering biological specifics of maintaining and improving the soil fertility when selecting the crops, in particular, replenishment of its organic component. The comparative recording of root and after harvesting residue of the crops within the plowing layer showed that one of the soybean was maximum, and the minimum share was of rapeseeds 1.68 t/ha. Ammonium salts and salts of nitrogen acid are known to be the main sources of nitrogen feeding of the plants. The soils in the south and south – east of Kazakhstan are famous for a high nitrification capacity, and so ammoniacal nitrogen produced in the result of mineralization of the organic substance in the soil or added together with the fertilizers, is rapidly engaged in the nitrification process.

Table 2. Volume of the root and after harvesting residues under crops within the layer 0-20 cm, t/ha

Experiment option	Spring rapeseeds	Carthamus	Soybean	Spring barley
Control	1.68	2.37	3.40	2.98
High 150+$N_{60}P_{60}$	3.05	3.58	4.64	4.16

Note: for soybeans, option $P_{150}+P_{60}+M_0$

In our researches, the dynamics of the mineral nitrogen, depending on application of different types of fertilizers for the soybean planting, were determined for the three terms – seedling, blossoming and full maturity (Table 3). The table 3 showed that at the beginning of vegetation, content of mineral nitrogen is relatively low (on average for the two years) both in the plowing (26.4 mg/kg), and subsurface layers of the soil (21.7 mg/kg). Furthermore, its considerable part was represented by the nitrate form. The relatively low content of the mineral nitrogen was observed in options with the straw after effect and cow dung. The microelements added in 2012 did not have any noticeable (effect) on the content of nitrogen in the soil. The table shows that the organic fertilizers materially increased the content of the mineral nitrogen both in the plowing and subsurface layers of the soil. So, for example, in the option involving the addition of 45 t of cow dung/ha, the content of mineral nitrogen during on average for the two years of the effect within the plowing layer was 39.7 mg/kg, and during subsurface layers of its effect – 26.8 mg/kg of dry soil. Due to the addition of 30 t of cow dung/ha, the volume of mineral nitrogen grew to 33.1 mg from 6.0 t/ha, vermicompost to 31.8 mg from 3.0 t/ha, vermicompost 28.3 mg/kg of soil, when its reference volume was 26.4 mg/g. The minimum number of mineral nitrogen was observed in case of addition of 6.0 t of grain straw /ha – 25.4 mg in the plowing layer and 23.2 mg/kg of soil in the subsurface layer. It should be noted that a high content of mineral nitrogen was also observed in the option with addition of 30 t of cow dung/ha and 32.3 mg in the plowing layer and 29.5 mg/kg of soil in the subsurface layers. The table shows that in 2013, the content of mineral nitrogen in the soil during the first estimation period was somewhat lower than in 2012. Besides, it is possible to note the absence of a large difference between the options, excluding the option with 45 t of cow dung /ha, where the after effect is noticeable, versus the other options of the application of the organic fertilizers. The peculiarity of the dynamics of mineral nitrogen beneath the soybean planting can be deemed as its relatively high content in the plowing and subsurface layers of the soil during the whole vegetation period of the plants, up to the full maturity phase.

Table 3. Dynamics of mineral nitrogen in the soil beneath soybeans, in mg/kg of soil

Experiment options	Soil layer, cm	Seedling	Blossoming	Full maturity
		Average for 2 years	Average for 2 years	Average for 2 years
Control without fertilizers	0-20	26.4	23.9	17.6
	20-40	21.7	22	18.2
Recommended rate $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	27.1	26.3	17.7
	20-40	21.4	24.1	23.2
Recommended rate+microelements $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	25.1	28	19.2
	20-40	22.9	26.1	22.1
Recommended rate $P_{80}K_{25}$+Mo (1.5) $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	28.6	27.3	17.2
	20-40	21.1	21.1	21.6
Recommended rate $P_{80}K_{25}$+Co(1.5)	0-20	28.1	26.4	18
	20-40	22.2	22.8	22.6
Recommended rate $P_{80}K_{25}$+Zn(1.5)	0-20	28.6	24.6	18.0
	20-40	21.7	22.4	24
Cow dung 45 t/ha effect and after effect	0-20	39.7	34.8	22
	20-40	26.8	29.3	26.2
Cow dung 30 t/ha effect and after effect	0-20	33.1	34.1	19.9
	20-40	24.1	29.3	24.3
Vermicompost 6.0 t/ha effect and after effect	0-20	31.8	27.6	20.4
	20-40	25.4	28.4	22.5
Vermicompost 3.0 t/ha effect and after effect	0-20	28.3	24.0	19.0
	20-40	24.3	20.3	21.6
Straw 6,0 t/ha effect and after effect	0-20	25.4	24.0	16
	20-40	23.2	21.9	20.6
Straw 6.0 t/ha+cow dung effect and after effect	0-20	31.2	31.4	20.4
	20-40	27.1	25.5	23.1
Cow dung 30 t/ha effect and after effect	0-20	32.3	30.1	20.9
	20-40	29.5	26.5	25.7
Microelements (Mo, Co, Zn) effect and after effect	0-20	26.5	30.8	16.9
	20-40	21.2	25.6	21.7

It is known that the main source of the phosphor feeding for the plants is mineral phosphor being the majority of the total phosphor in the soil (Table 4). Despite the fact that chestnut soils in the south – east of Kazakhstan contain large reserves of total phosphor, including mineral one, nevertheless, they are mostly famous for a lower content of the liable form of phosphor available to the plants. The results of our researches showed that the content of labile phosphor in the soil beneath the soybeans was on average 22.1 mg/kg of soil in the plowing layer and 18.4 mg/kg of soil in the subsurface layer, during the two years in the reference option (without fertilizers). The table shows that the addition of designed rates of fertilizers promoted the increase in the content of labile phosphor up to 28.8 mg/kg, i.e. 6.7 mg higher than the reference option and somewhat lower than in 2013 (6.2 mg/kg of soil). The joint addition of the designed rates of phosphor – potassium fertilizers and microelement (Mo+Co+Zn) separately and as a set did not affect the volume of available phosphor in the soil. The organic fertilizers, other than straw, encouraged the rise in labile phosphor both during on average for the two years of its effect (from 24.2 to 24.0 mg/kg). However, the table shows that by the effect on the volume of labile phosphor in the soil during the second year – it is possible to note the addition of 45 t of cow dung /ha, when its volume was at least as during on average for the two years of its effect – 27.9 mg. Due to the effect of vermicompost, cow dung during the second year, the content of labile phosphor rises insignificantly by 24.2 – 22.7 mg, whereas its volume in the reference option was 22.1 mg/kg. During the vegetation the content of labile phosphor in the soil reduced in all options of the experiment in both layers, but the difference between the options survives till the end of vegetation. Thus, fertilizers being an efficient factor of the changed efficient soil fertility had a material effect both on the total number of feeding substances in the soil, and peculiarities of their labile forms. The previous researches showed that when the phosphor – potassium feeding is adequate and the seeds are treated with the corresponding bacteria strains and microelements are added, the nitrogen fertilizers should not be used for soybeans.

Table 4. Dynamics of labile phosphor in the soil beneath soybeans, mg/kg of soil

Experiment options	Soil layer, cm	Seedling	Blossoming	Full maturity
		Average for 2 years	Average for 2 years	Average for 2 years
Control without fertilizers	0-20	22.1	20.1	17.2
	20-40	18.4	17.3	13
Recommended rate $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	28.8	28.5	21.9
	20-40	18.5	16.8	14.9
Recommended rate + microelements $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	29.1	26.6	21.4
	20-40	17.9	17	13.8
Recommended rate $P_{80}K_{25}$+Mo (1.5) $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	0-20	28.2	26.7	22.3
	20-40	19.5	17.6	14.6
Recommended rate $P_{80}K_{25}$+Co(1.5)	0-20	28.8	26.4	21.0
	20-40	19.3	17.1	13.1
Recommended rate $P_{80}K_{25}$+Zn(1.5)	0-20	27.6	24.9	19.8
	20-40	18.4	16.7	14.0
Cow dung 45 t/ha effect and after effect	0-20	27.9	27.8	25.0
	20-40	19.2	18.1	14.3
Cow dung 30 t/ha effect and after effect	0-20	26.6	25.2	22.0
	20-40	18.0	16.4	14
Vermicompost 6.0 t/ha effect and after effect	0-20	26.9	24	20.1
	20-40	17.5	16.7	13.7
Vermicompost 3.0 t/ha effect and after effect	0-20	25.7	23.8	19.6
	20-40	18.1	15.7	12.9
Straw 6,0 t/ha effect and after effect	0-20	21.9	19.7	18.4
	20-40	18.9	16.4	13.1
Straw 6.0 t/ha + cow dung effect and after effect	0-20	24.6	22.7	20.1
	20-40	20.5	17.3	12.9
Cow dung 30 t/ha effect and after effect	0-20	24.2	24.0	19.9
	20-40	19.9	18.1	12.4
Microelements (Mo, Co, Zn) effect and after effect	0-20	21.9	19.8	17.5
	20-40	18	17.1	13.1

So, results of our researches showed that the designed rates of the phosphor – potassium fertilizers encouraged the growth in the yielding capacity of soybeans up to 3.25 t/ha, whereas the reference value (without fertilizers) was 2.73 t/ha, the surplus was 0.52 t/ha (Table 5). The addition of three microelements (Mo, Co, Zn) whether jointly or separately against the low of phosphor – potassium fertilizers somewhat increased the yielding capacity of soybean, though insignificantly versus the low (from 0.06 to 0.14 t/ha), which was within experimental error. As to the organic fertilizers, the maximum yielding capacity was achieved by adding 45 t of cow dung/ha (3.49 t of grain/ha), it was somewhat lower when adding 30 t of cow dung/ha (3.43 t/ha). The table shows that due to the addition of Bio humus (3.0-6.0 t/ha), almost the same surplus was achieved as due to the mineral fertilizers (0.58-0.64 t/ha). Straw (6.0 t/ha) failed to have any effect in fact on the yielding capacity of soybean, as the effect was only 0.06 t/ha. An insignificant surplus (0.29 t/ha) was achieved by adding the cow dung together with straw, as well as by adding only microelements (Mo, Co, Zn) – 0.17 t/ha. The table shows that the level of yielding capacity of soybean in 2013 was higher versus the previous year, whether in the reference (2.80 t/ha) or fertilizer options, and the surplus due to the designed rates of mineral fertilizers were significantly higher (0.70 t/ha). The surplus in the grain harvest due to the after effect of microelements is almost naught (0.01-0.0 t/ha against the Low PK). Of the organic fertilizers, only the after– effects of cow dung added at the rate of 30-45 t/ha provided a noticeable surplus in the harvest (0.43-0.55 t/ha).

Table 5. The yielding capacity of soybean depending on application of fertilizers, in t/ha

Experiment options	Yielding capacity, t/ha					
	2012	Surplus due to fertilizers, t/ha, 2012	2013	Surplus due to fertilizers, t/ha, 2013	Average for 2 years	Surplus due to fertilizers, t/ha
Control without fertilizers	2.73	–	2.80	–	2.76	
Recommended rate $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	3.25	0.52	3.50	0.70	3.37	0.61
Recommended rate+microelements $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	3.39	0.66	3.59	0.79	3.49	0.72
Recommended rate $P_{80}K_{25}$+Mo (1.5) $P_{80}K_{25}$–2012 $P_{70}K_{20}$–2013	3.38	0.65	3.55	0.75	3.46	0.7
Recommended rate $P_{80}K_{25}$+Co(1.5)	3.25	0.52	3.51	0.71	3.38	0.61
Recommended rate $P_{80}K_{25}$+Zn(1.5)	3.31	0.58	3.51	0.71	3.41	0.64
Cow dung 45 t/ha effect and after effect	3.49	0.76	3.35	0.55	3.42	0.65
Cow dung 30 t/ha effect and after effect	3.43	0.70	3.23	0.43	3.33	0.56
Vermicompost 6.0 t/ha effect and after effect	3.37	0.64	3.09	0.29	3.23	0.46
Vermicompost 3.0 t/ha effect and after effect	3.31	0.58	3.01	0.21	3.16	0.39
Straw 6,0 t/ha effect and after effect	2.79	0.06	3.00	0.20	2.89	0.13
Straw 6.0 t/ha+cow dung effect and after effect	3.02	0.29	3.04	0.24	3.03	0.26
Cow dung 30 t/ha effect and after effect	3.02	0.29	3.02	0.22	3.02	0.25
Microelements (Mo, Co, Zn) effect and after effect	2.90	0.17	2.95	0.15	2.92	0.16
LSD 0,05, t/ha	1.31		2.49			

The after effect of vermicompost (3.0-6.0 t/ha) was not so significant and the surplus varied between 0.21 and 0.29 t/ha. The same insignificant surplus was achieved due to the after effect of cow dung, microelements, and straw. However, it should be noted to the peculiarity that becomes evident in the fact that the straw after effect on the yielding capacity of soybean was higher than the direct effect during the first year of the researches. Such effect of the straw on the yielding capacity of different crops was observed also during the other researches, despite the fact that during the application of straw it is advised to add also a nitrogen fertilizer.

Conclusions

Thus, the results of our researches showed that the mineral and organic fertilizers are an efficient factor as a part of the resource saving technology used to grow the promising leguminous crops, which increase substantially the yielding capacity and gross harvest of the seeds in the conditions of diversification of crop science in the south – east of Kazakhstan.

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