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THE INFLUENCE OF LEGUMES ON SOIL FERTILITY IN THE DRY STEPPE ZONE OF THE ABAY REGION

ANNOTATION

In the Abai region, it is necessary to improve soil fertility in order to obtain yields[1]. The production of agricultural crops has always been given great attention, as it provides the population with food, supplies raw materials for industry, serves as animal feed, and is also the main object of international economic relations[2,3]. Soil fertility is already deteriorating in the regions of the Abai region. Food security, reducing the risk of climate change and meeting the growing demand for energy will become increasingly important tasks in the coming years. The soils of the Agrobiolaboratory of this site are degraded. [4].

The aim of the research was the influence of legumes on soil fertility in the dry steppe zone of the Abai region. Field experiments were conducted on light chestnut medium-sized soils of medium loamy mechanical composition. The objects of the study are legumes, together with bacteria, which play a huge role in the nitrogen balance of the soil. In the conditions of the dry steppe zone, the moisture supply of plants is a factor limiting the yield of crops. Moisture reserves in the soil are created here solely due to atmospheric precipitation. One of the real and economically beneficial ways to stop the decline in soil fertility and increase agricultural production, along with the use of chemicals, is to intensify the biologization of agriculture. Due to the presence of nodules with a large number of nodule bacteria on their roots, they are able to convert air nitrogen into a form available for assimilation by plants[5]. After the death of plants, legumes increase the nitrogen content in the soil, and thus the legume-rhizobial symbiosis pumps nitrogen from the atmosphere into the soil[6,7]. According to the results of studies of atmospheric nitrogen fixation, legumes in symbiosis with bacteria can accumulate, depending on the biological characteristics of the culture, from 100 to 300 kg/ha of bound nitrogen per year

Key words: *legumes, peas, soil fertility, dry steppe zone, mineral fertilizers.*

Introduction. Legumes play an important role in the agricultural economy of Kazakhstan, especially in the dry steppe regions, where farming conditions are limited due to lack of precipitation and high climate variability. Effective cultivation of legumes in these conditions requires the use of specialized agricultural technologies aimed at preserving moisture, improving soil structure and fertility, as well as increasing crop resistance to drought [8].

Therefore, along with many solvable problems. Soil preparation and optimal sowing times are also crucial for the success of legume cultivation. Proper soil preparation ensures good aeration, promotes moisture retention and creates favorable conditions for the development of the root system. [9]. Optimal sowing times help plants make better use of spring moisture and avoid periods of drought during the growing season. Thus, an integrated approach to the cultivation of legumes in the dry steppe zone of Kazakhstan, including the use of modern agricultural technologies and taking into account local climatic characteristics, can contribute to the sustainable development of the agricultural sector and increase food security of the country [10]. Taking into account the climatic and resulting soil characteristics of the region, the leading component of the agricultural system is a scientifically based soil protection system of agriculture [11]. The introduction of all elements of soil-protective agriculture makes it possible to ensure high and sustainable yields of field crops while simultaneously increasing soil fertility and creating favorable environmental conditions. The leading component of the farming system is crop rotation, as a scientifically based alternation of crops, built taking into account the accepted structure of acreage and providing both an increase in soil fertility and an increase in the productivity of cultivated crops [12,13]

Materials and methods of research. Within the framework of the project, 40 soil samples were taken to assess soil fertility in the Agrobiolaboratory. The selection was carried out in early June 2024 from the upper horizon with a depth of 0-20 cm using the "envelope" method. The content of organic matter in the studied soil ranges from 3.43 (sample 3) to 6.37, with an average content of 4.49%. According to GOST R 55627-2013, the optimal indicator of the content of organic matter is considered to be a value above 3%. Nitrogen is the most important element of the mineral nutrition of plants, the availability of which largely determines the efficiency and stability of the functioning of agroecosystems. The need of plants for nitrogen is mainly due to soil reserves. The content and distribution of nitrogen in the soil depend on natural and environmental factors that determine the microbiological activity of soils. The degree of manifestation of these factors is determined and depends on the main factors of soil formation, climate and terrain. It is the mineral nitrogen that is the main source for plants. The content of mineral nitrogen, determined by the Tyurin and Kononova methods, varies from 54.88 to 101.92 with an average value of 71.81 kg/ha, which indicates an increased content of it in the soil. It is recommended to normalize the moisture level in the soil by hydro-reclamation, the addition of peat or humus. The growth and development of plants depend on the ratio of hydrogen ions (H^+) and hydroxyl (OH^-) in the soil, i.e. on the reaction of the soil environment. If hydrogen ions prevail, the soil is acidic, hydroxyl ions are alkaline. Both strongly acidic and alkaline soils are unfavorable for plants [14].

To determine the percentage of structural units of this size in the soil, the percentage of fractions 1-2 mm, 2-3 mm, 3-5 mm is summed up: well-structured soils contain aggregates from 1 to 5 mm in size more than 80%, medium-structural - from 30 to 80% and poorly structural - less than 30%, structureless - 5-10%. The studied soils are characterized as poorly structured.The results of the chemical analysis of the soil are presented in Table 1. To study the physico-chemical properties of the soil, methods of physico-chemical analysis were used: to obtain a soil extract, the extraction method, the study of the mechanical composition – dry sieving, the pH of the soil solution – potentiometric titration, the elemental composition – optical emission spectroscopy, the content of organic substances and field humidity – gravimetry. The repetition of the experiments is threefold.

The elemental analysis of soil samples was carried out on the EXPEC-6500 instrument by optical emission spectroscopy. The content of calcium, cadmium, magnesium, potassium, sodium, phosphorus, iron, zinc, aluminum and other elements in acidic soil extraction was determined.

The extract was prepared as follows: 2 g of dry soil was placed in a round-bottomed flask, 20 ml of a 3% nitric acid solution was added and stirred on a reciprocating LOIP LS-120 shaker for 60 minutes. The resulting soil suspension was filtered through a paper filter. The resulting filtrate was diluted 50 times with distilled water and analyzed on an optical emission spectrometer.

To calculate the concentration of the element in the soil (mg/g), the formula was used:

$$C=(a\times 20)/(0.5\times 2\times 1000) \quad (1)$$

where C is the concentration of the element, mg/g;
a is the concentration value of the element shown by the device, mcg/ml;
20 – volume of the hood, ml;
2 – weight of the soil sample, g;
1000 – conversion coefficient

Table 1 – Elemental composition of the soil sampled in the Agrobiolaboratory

Element	The contents of the element in the soil sample, mg/g						
	1	2	3	4	5	6	7
K	0,47±0,02	0,29±0,01	0,47±0,02	0,35±0,01	0,26±0,00	0,41±0,01	0,26±0,00
Na	0,54±0,03	0,33±0,01	0,25±0,01	0,36±0,02	0,23±0,01	0,40±0,02	0,16±0,00
Ca	3,57±0,3	2,48±0,16	3,35±0,18	2,29±0,12	2,29±0,12	3,25±0,09	2,82±0,00
Mn	0,27±0,01	0,39±0,00	0,18±0,00	0,18±0,00	0,23±0,00	0,20±0,00	0,12±0,00
Al	1,25±0,02	2,41±0,11	1,32±0,03	1,52±0,01	2,20±0,09	1,62±0,02	0,82±0,01
Cr	0,11±0,00	0,11±0,00	0,10±0,00	0,10±0,00	0,10±0,00	0,10±0,00	0,10±0,00
Fe	0,43±0,01	0,68±0,06	0,50±0,01	0,54±0,01	0,80±0,04	0,56±0,01	0,65±0,01
Mg	0,77±0,01	1,64±0,06	0,72±0,01	0,79±0,02	1,13±0,05	0,84±0,01	0,43±0,00
P	0,87±0,04	0,37±0,01	0,60±0,03	0,55±0,02	0,63±0,02	0,55±0,02	0,88±0,04

The elemental composition of the soil during agroecological studies is a necessary quantitative diagnosis to determine the amount of easily soluble (mobile) macronutrients (nitrogen, phosphorus, potassium, etc.) and trace elements (manganese, etc.) absorbed by plants, as well as to calculate the proportion of technogenicity of the elements. According to the analysis, the availability of soil nutrients is revealed and the fields' need for fertilizers is determined. In the studied soils, the oscillation amplitude of mobile phosphorus ranges from 0.37 to 0.88 mg/g; mobile potassium - from 0.26 to 0.47 mg /g, which corresponds to a more than sufficient level of their content in the soil. The content of all microelements-metals corresponds to hygienic standards [15].

Table 2 – Physico-chemical properties of the soil selected on the territory of the agrobiolaboratory

Sample	Mass of organic matter, g/mass of the studied soil sample, g	The content of organic matter, %	Mineral nitrogen content, kg/ha	Soil moisture		pH		The content of fractions, %		
				g	%	water	Sol r	5-1 mm	5-2 mm	2-1м
1-1	0,2387 / 4,7374	5,04	80,64	0,50	10,02	8,2	6,5	13,55	6,05	7,50
1-2	0,2480 / 4,6762	5,30	84,80	0,49	9,74					
1-3	0,2516 / 4,4996	5,59	89,44	0,50	10,02					
2-1	0,2294 / 4,6136	4,97	79,52	0,49	9,26	8,2	6,8	25,05	13,07	11,98
2-2	0,2228 / 3,4388	6,37	101,92	0,68	12,85					
2-3	0,2252 / 4,6230	4,87	77,92	0,57	11,54					
3-1	0,1620 / 4,7253	3,43	54,88	0,64	12,70	7,5	7,0	21,08	10,53	10,55
3-2	0,1736 / 4,7826	3,63	58,08	0,59	11,82					
3-3	0,1690 / 4,7734	3,54	56,64	0,67	11,51					

Soil organic matter is a factor of soil fertility, a source of energy for its development and formation, serves as a kind of reserve of nutrients necessary for plants, has a great influence on the structure of the soil, is an energy source for many beneficial microorganisms (Table 2). The content of organic matter in the studied soil ranges from 3.43 to 6.37, with an average content of 4.49%. According to GOST R 55627-2013, the optimal indicator of the content of organic matter is considered to be a value above 3% [16]. Nitrogen is the most important element of the mineral nutrition of plants, the availability of which largely determines the efficiency and stability of the functioning of agroecosystems [17].

The necessity of plants for nitrogen is mainly due to soil reserves. The content and distribution of nitrogen in the soil depend on natural and environmental factors that determine the microbiological activity of soils [18,19]. The degree of manifestation of these factors is determined and depends on the main factors of soil formation, climate and terrain. It is the mineral nitrogen that is the main source for plants. The content of mineral nitrogen, determined by the Tyurin and Kononova methods, varies from 54.88 to 101.92, with an average value of 71.81 kg/ha, which indicates an increased content of it in the soil [20].

Results of the research and its analysis. As part of the study, 40 soil samples were taken to assess soil fertility in the Agrobiolaboratory. The selection was carried out in early June 2024 from the upper horizon with a depth of 0-20 cm using the "envelope" method, after which mixed samples were prepared from each point. The soil of the agrobiolab territory belongs to light chestnut soils.

At all stages of experimental research, the basic methodological requirements were observed: compliance with the principle of the only difference, that is, compliance with the unity of all cultivation conditions except for one studied, the obligation to set up experiments on sites homogeneous in climatic and soil factors and study in time and space.The experience was laid in the first decade of June, the soil was plowed on 06/13/2024, the planting of peas was carried out on 06/14/2024. The seeds of the “Atlant” variety were sown in two plots with row spacing of 20x50 cm.

Experience 1. On 1.5 acres of land The scheme of the experience: 1. Sowing peas with watering to a depth of 5-7 cm with a growth stimulant for plants.

Experience 2. On 2 acres of land The scheme of the experiment: Sowing peas to a depth of 5-7 cm with watering without a growth stimulant.

Picture 1 – Bacteroids on the roots

As our research has shown, legumes do not absorb nitrogen well in hot weather. Therefore, there is a nitrogen deficiency in them As can be seen in the figure, there are very few bacteroids on the roots of peas (picture 2). Bacteroides is a genus of Gram-negative, obligate anaerobic bacteria. Bacteroides species are non endospore-forming bacilli, and may be either motile or nonmotile, depending on the species. The DNA base composition is 40–48% GC. Unusual in bacterial organisms, Bacteroides membranes contain sphingolipids. They also contain meso-diaminopimelic acid in their peptidoglycan layer. When the temperature in the root layer of the soil is 300C, endogenous bacteria are not formed in the root and free nitrogen is not absorbed.

Picture 2 – Seed peas. Seeds, seedlings, planting area

During the research, the level of soil fertility was determined, and the optimal depth of sowing pea seeds was established. The seeds were planted to a depth of 5-7 cm.

Picture 3 – Phenological observations of peas

The first shoots of peas with a growth stimulant on the site of Experiment 1 were recorded on 06/26/2024. On the second site, the first shoots appeared on 06/28/2024. The time of mass flowering of peas when watering with the addition of a growth stimulant has already been observed On 07/24/2024, while the mass flowering of peas on the site without a stimulant was recorded later, on 07/29/2024. The height of the plants of Experiment 1 with a growth stimulant is about 5-8 cm higher. The ripeness of the seeds was already observed on 08/02/2024.

Conclusions. As our research has shown, legumes do not absorb nitrogen well in hot weather. Therefore, there is a nitrogen deficiency in them As can be seen in the figure, there are very few bacteroids on the roots of peas. When the temperature in the root layer of the soil is 300C, endogenous bacteria are not formed in the root and free nitrogen is not absorbed.Combined tillage and adaptively integrated plant protection contributed to an earlier (2-3 days) and prolonged general symbiosis of nodules compared with minimal treatment and the first level of plant protection. Nodules formed 10-12 days after germination. On 8-10 days after the formation of nodules, a red pigment appeared in them – leghemoglobin (Lb), which provides oxygen to energy centers and promotes the release of energy to fix nitrogen in the air. Based on agrochemical analysis, a comprehensive assessment of soil properties that determine plant growth and development, such as mechanical composition, field humidity, environmental reaction (pH), saturation with macronutrients and trace elements, organic matter, availability of nutrients (nitrogen, potassium, phosphorus), was carried out. The study shows that the balance of elements meets the needs of plants, it is necessary to increase soil moisture and structure in order to obtain sustainable yields.

By about the middle of the seed filling phase, the nodules began to turn green – leghemoglobin turns into choleglobin (Cb), and by the beginning of the full seed filling phase, the nodules died off. Figure 10 shows data on the duration of the general and active symbiosis of grain legumes. When cultivating grain legumes, it is necessary to take into account that high yields can be obtained under the condition of a well-developed symbiotic apparatus, which is directly dependent on the root system. A more developed root system was observed in variants with adaptively integrated plant protection, this is due to the fact that pre-sowing seed treatment had a greater impact on the safety and protection of plants from diseases.

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ТҮЙІН

"Қазіргі жағдайда Абай облысында Қазақстан Республикасының азық-түлік қауіпсіздігін қамтамасыз ету үшін тиімді жұмыс істейтін нарықтық экономика құру қажет. Қалыптасқан әлемдік үрдістерде Қазақстанның шаруашылық салалары арасында ең жоғары табыстылықты агроөнеркәсіптік кешен өзінің үлкен табиғи-климаттық агропотенциалы есебінен қамтамасыз етеді. Қазақстан жоғары технологиялық қасиеттері бар дәнді дақылдарды өсіру үшін бірегей табиғи жағдайларға ие. Астық өндіру мәселелеріне әрдайым көп көңіл бөлінді, өйткені ол халықты азық-түлікпен қамтамасыз етеді, өнеркәсіпке шикізат жеткізеді, жануарларға жем ретінде қызмет етеді, сонымен қатар Халықаралық экономикалық қатынастардың негізгі объектісі болып табылады. Қазақстанның құрғақ дала аймағында бұршақ дақылдарын өсіру климат пен топырақтың ерекшеліктерін ескеретін кешенді тәсілді талап етеді. Абай облысының өңірлерінде қазірдің өзінде топырақ құнарлылығының нашарлауы байқалады. Азық-түлік қауіпсіздігі, климаттың өзгеру қаупін азайту және энергияға деген өсіп келе жатқан сұранысты қанағаттандыру алдағы жылдары маңызды міндеттерге айналады.

Топырақ құнарлылығының төмендеуін тоқтата тұруды және химияландыру құралдарын қолданумен қатар ауыл шаруашылығы өнімін өндіруді ұлғайтуды қамтамасыз ететін нақты және экономикалық тиімді жолдардың бірі Ауыл шаруашылығын биологияландыруды қарқындату болып табылады. Ауыл шаруашылығын биологияландырудың негізі-дәнді-бұршақты дақылдарды ауыспалы егіске енгізу. Бұршақ өсімдіктері бактериялармен бірге топырақ азотының тепе-теңдігінде үлкен рөл атқарады.

Олардың тамырларында түйін бактериялары көп түйіндердің болуына байланысты олар ауа азотын өсімдіктердің ассимиляциясы үшін қол жетімді түрге ауыстыра алады. Өсімдіктер өлгеннен кейін бұршақ дақылдары топырақтағы азотты көбейтеді, осылайша бұршақ-ризобиалды симбиоз азотты атмосферадан топыраққа айдайды. Атмосфералық азотты бекіту арқылы бактериялармен симбиоздағы бұршақ дақылдары дақылдың биологиялық ерекшеліктеріне байланысты жылына 100-ден 300 кг/га-ға дейін байланысқан азот жинай алады.

РЕЗЮМЕ

В современных условиях для обеспечения продовольственной безопасности Республики Казахстан в Абайской области необходимо построение эффективно действующей рыночной экономики. В сложившихся мировых тенденциях наиболее высокую доходность среди хозяйственных отраслей Казахстана обеспечивает агропромышленный комплекс за счет своего большого природно-климатического агропотенциала. Казахстан обладает уникальными природными условиями для возделывания зерновых культур с высокими технологически качествами. Вопросам производства зерна всегда уделялось большое внимание, так как оно обеспечивает население продовольствием, поставляет сырье для промышленности, служит кормом для животных, а также является главным объектом международных экономических

отношений. Возделывание бобовых культур в сухостепной зоне Казахстана требует комплексного подхода, учитывающего особенности климата и почвы. В регионах Абайской облости уже сейчас наблюдается ухудшение плодородий почв. Продовольственная безопасность, снижение риска изменения климата и удовлетворение растущего спроса на энергию будут становиться все более важными задачами в предстоящие годы.

Одним из реальных и экономически выгодных путей, обеспечивающих приостановление падения плодородия почв и увеличения производства сельскохозяйственной продукции, наряду с применением средств химизации, является интенсификация биологизации земледелия. Основа биологизации земледелия - введение в севооборот зернобобовых культур. Бобовые растения совместно с бактериями играют громадную роль в балансе азота почвы. Благодаря наличию на их корнях клубеньков с большим количеством клубеньковых бактерий, они способны переводить азот воздуха в доступную для усвоения растениями форму. После отмирания растений бобовые увеличивают содержание азота в почве, и таким образом бобово-ризобиальный симбиоз перекачивает азот из атмосферы в почву. За счет фиксации атмосферного азота бобовые растения в симбиозе с бактериями могут накапливать в зависимости от биологических особенностей культуры от 100 до 300 кг/га связанного азота в год.

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БАТЫС ҚАЗАҚСТАН ОБЛЫСЫ ЖАҒДАЙЫНДА ЕРТЕ ОТЫРҒЫЗУ КЕЗІНДЕ КАРТОП ӨСІМДІКТЕРІНІҢ ФОТОСИНТЕТИКАЛЫҚ БЕЛСЕНДІЛІГІ
PHOTOSYNTHETIC ACTIVITY OF POTATO PLANTS AT EARLY PLANTING DATES IN THE CONDITIONS OF THE WEST KAZAKHSTAN REGION

Аннотация

Батыс Қазақстанда картоп суару жерлерде өсіріледі. Ауа температурасы ыстық жылдары өсу үшін фотосинтетикалық белсенділікке өте маңызды болуы мүмкін. Фотосинтетикалық белсенділік картоп өнімділігінің негізі болып табылады. Максималды фотосинтетикалық өнімділікке қол жеткізу үшін экзогендік факторлардың оңтайлы болуы қажет–ылғал, жарық режимі, минералды қоректену және температура жағдайлары.

Батыс Қазақстан облысы жағдайында, кейбір зерттеушілердің айтуы бойынша [1], ерте отырғызу кезінде картоптың ерте пісетің сорттары жер үсті массасымен столондарды тез