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EFFECTS OF SOIL CULTIVATION AND FERTILIZERS ON PROTEIN YIELD IN REPEATED SUMMER CROPS OF SOYBEAN

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Abstract. In the paper we study of the effect of soil cultivation and mineral fertilizers on protein yield in repeated summer sowing of soybeans in irrigated gray-brown (chestnut colour) soils under the conditions of Samukh region (Azerbaijan). It was determined that due to the effect of soil cultivation and mineral fertilizers, the yield of soybean protein in the field cultivated at the depth of 8-10 cm was 52.4-303.7 kg/ha; in the field cultivated with a disk trowel at the depth of 13-15 cm was 91.6-372, 1 kg/ha; in the 20-22 cm deep plowed area, protein yield increased between 71.0-480.4 kg/ha, compared to the control (without fertilizer) variant. The highest protein yield was obtained in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers in all three soils cultivations and in the plowed field at a depth of 20-22 cm among the soil cultivations.

Keywords: *soil cultivation, soybean, protein yield, barley, repeated, summer, cultivation, plow, gray-brown, mineral fertilizers.*

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1. Introduction

Being an important fat-protein plant, soybean has a wide range of applications. Currently, up to 1000 food products are produced from soy, including oil, yogurt, milk, cheese, etc. Soy products are quickly digested by the human body. Adding soy protein to protein obtained from other plants increases its nutritional value. Soy products are an excellent dietary supplement for diabetics, obese people, and vegetarians. In humans, it is very important in the treatment of cardiovascular and cancer diseases, and in the regulation of blood cholesterol (Gavrilin & Polevshchikov, 2014).

In the research conducted by A.P. Khudiyev and G.Y. Mammadov in the Ganja-Gazakh zone, the fodder yield and quality indicators of pure and mixed crops of soybean and corn were studied under irrigation conditions. It was determined that 5418 kg of feed units and 903 kg of digestible protein were obtained from soybeans cultivated in pure planting. (Khudiyev & Mammadov, 2012).

The effect of irrigation methods and fertilizer rates on the productivity of soybeans cultivated in the field was studied in the research conducted by Sh.H. Ahmedov, M.Y. Rzayev, Z.M. Abdullayeva. In the conditions of Azerbaijan, there are wide opportunities for the cultivation of soybeans and the production of high grain and green mass. Soy is a heat-loving plant, the temperature required for its development and ripening is 17-32 C. The optimal temperature for seed germination should be 20-22 C. During the period of soybean flowering and bean formation, heat demand is high. Along with spring crops of soybeans, it is economically very profitable to cultivate barley after harvesting. In irrigated lands, seeding in slope makes it possible to get additional grain and fodder from

a single area, and to use reclamation facilities efficiently. At this time, the soil is enriched with organic substances, its salinization is prevented, and the problems of wind erosion and weed control are completely solved. Cultivation of crops carried out in slope, on large farms increases the possibility of more efficient use of labor force, irrigation water, irrigation networks, agricultural machinery and equipment (Ahmadov *et al*., 2016).

Soy is a universal and technical plant. Since the chemical composition of soybean is very rich in nutrients, it is used as a food, technical and valuable agricultural plant. Increasing plant protein production is one of the main issues facing biology and agricultural science Soy is very important in strengthening the fodder base of animal husbandry, improving the quality of the product, and reducing the cost. Food protein deficiency is observed in many countries of the world. The lack of protein in the countries is covered by animal products. To solve this problem, it is more appropriate to plant high-protein plants. One of these plants is soybean, which is a technical and fodder plant. Its composition is rich in unique irreplaceable vitamins, and it is considered a valuable raw material in the production of food products. Since the products of cereals and legumes are rich in protein, they are cultivated for food, fodder and technical purposes. Since the protein content of the produced feeds is low, that is, the presence of 75-80 g of protein in 1 feed unit leads to higher costs of feeds. This causes livestock products to become more expensive. According to the zootechnical norm, 1 feed unit should contain 115 g of crude protein. The grains of leguminous plants contain all the amino acids necessary for the human and animal body. Seeds and fruits contain a large amount of various vitamins (A, B_1, B_2, C, PP, etc.) necessary for the normal functioning of the body. Because of all this, cereals and legumes are extremely important as they are the main sources of high-protein food products and various types of fodder for farm animals. Legumes have several advantages over other non-legumes. First of all, the vegetative and generative organs of legumes are 2-3 times richer in protein than other plants. One feed unit of soybean green mass contains 185 g of digestible protein, 164 g of forage beans, 164 g of green peas, and 128 g of green peas. There are 251 grams of digestible protein in one feed unit of soybeans, 276 grams of lupine, 174 grams of green peas, 218 grams of sorghum, and 209 grams of fodder beans. When agricultural animals are fed with a mixture of cereals and legumes, the assimilation capacity of protein in grains increases by 20-50%. 80-90% of the protein of leguminous plants is well absorbed by the animal body. One advantage of legumes is that they collect a lot of nitrogen elements in a single soil area. If wheat can produce 360 kg of protein when 30 centners of grain are produced per hectare, peas can produce 690 kg of protein and soybean can produce 1260 kg of protein with the same amount of grain. One advantage is that the protein produced by legumes is very inexpensive to farm. The digestible protein in 1 ton of peas is 3 times cheaper than in cereals, and the protein in 1 ton of soybeans is 15-18 times cheaper. Legumes are good predecessors for most non-legumes. Legumes retain a significant amount of nitrogen and other useful elements in the soil with their root and shoot residues. Legumes are also grown for hay, green mass and silage. The grains of legumes are also rich in amino acids needed by the body. Non-replaceable lysine, methionine, tryptophan are more abundant in soybeans, beans, lentils, green peas and nuts. The percentage of absorption of the proteins contained in them is higher in the body. When legumes are harvested for green fodder in the stage of bean binding (at the beginning), 40 kg of nitrogen reserves remain in one hectare of land due to the roots. During the budding-flowering phase, 100-110 kg of nitrogen (green manure) is given to each hectare of land when the plant is plowed by turning it under the soil. Leguminous plants get most of the nitrogen they need to produce

from the free (biological) nitrogen in the air at the expense of the fungus bacteria living in their roots. A small part is paid for by the reserve nitrogen of the soil. Compared to other plants, legumes impoverish the soil less. The remains of leguminous plants left in the soil are quickly mineralized and create favorable conditions for the nutrition of the plants that come after them. The amount of protein in the green fodder of cereal crops is low. Thus, the amount of protein in the green mass of corn is 3 times less than that of green peas, and 3.5 times less than that of the seed. Therefore, in order to improve the quality of fodder, cereal plants are planted mixed with cereal-leguminous plants. When choosing components for mixed plantings, it is necessary to take into account their growth and development characteristics, as well as maturity periods. In mixed cropping, the amount of digestible protein in the green mass of cereal plants increases significantly. The nutritional value of the green mass product also depends on the ratio of the components in the total product. Thus, when the amount of rosewood mixture in the oats + vicia mixture reaches from 20-30% to 55-60%, the amount of digestible protein in the green mass increases from 9% to 14%. In order to achieve a favorable ratio of the components in the composition of the green mass product, it is necessary to choose the sowing method and the sowing scheme correctly:

1) 1-row of corn or sorghum, 1 row of beans;

2) 2 rows of corn or sorghum, 1 row of beans;

3) 2 rows of corn or sorghum, 2 rows of legumes. 2-3 corn and 4-5 bean seeds are sown in one nest.

Sometimes they take the rate of sowing in the ratio of 2:1. Since the stems are in a dormant state in clean plantings of green peas, sorghum, the crop is hard to harvest and its quality deteriorates. Therefore, these plants give good results when they are cultivated in a mixture with cereals and oilseeds that do not lie on the ground. Photosynthesis products in mixed crops are also higher than in pure crops. Therefore, mixed crops produce more dry matter, digestible protein and feed per unit area. Quality silage is obtained from the green mass of mixed crops. Up to 100-400 kg of nitrogen per hectare can be accumulated in the stems of leguminous plants, depending on the species. Therefore, legumes are important for increasing soil fertility in agriculture. In sandy soils poorly supplied with nutrients, when the green mass of legumes (lupin, blue pea, cowpea) is buried in the soil, the supply of both nitrogen and ash elements increases. Also, the water retention and water retention properties of the soil are improved. Air, food and water regimes become more favorable due to green manure in the heavy soils of our republic. For the purpose of green manure, a plant suitable for soil and climate conditions should be selected. In crops, the sowing period, sowing method and sowing norms should be taken into account. If they are followed, it is possible to harvest up to 400 centners of green mass per hectare. On this basis, the yield of potatoes increases by 2-3 times, and that of grain crops by 3.5-3.7 times. The green mass of cereal-legume plants is plowed into the ground at the beginning of the bean binding phase. Sowing for green manure can be done in spring, summer or autumn. Soybean farms receive 2 products: complete protein and vegetable oil. Soy protein is well soluble in water and easy to digest. The protein in soybeans is 3.6 times higher than that of barley and 4 times higher than that of corn. Soy is cultivated for food, fodder and technical purposes. Oil, margarine, soy cheese, milk, flour, confectionery, preserves and other products are obtained from soybeans. Soybean oil is a raw material for the soap making industry. At the same time, it is also used in the varnish industry. Soybean ranks first in the world in terms of vegetable oil production. Its share is 40%, and sunflower's share is 18-20%. What

distinguishes soy from other cereals and legumes is that its protein is close to animal protein in terms of its amino acid composition and is easily absorbed by the human body. Soy contains amino acids such as lysine, tryptophan and methionine. While 1 kg of wheat grain contains 2.5 grams of lysine, 1 kg of soybean flour contains 27 grams of lysine. Soybean meal and meal are very valuable fodder for animals. There is up to 47% protein in cotton-cake (compressed cotton seed) , and up to 40% protein in it. 1 kg of soybeans contains 1.31-1.47 feed units, 275-338 grams of digestible protein. In general, up to 400 different types of products are obtained from soybeans. Soybeans can also be grown for green fodder and silage. It is planted mixed with corn and sorghum for silage purpose.100 kg of soybean green mass contains 21 feed units, 3.5 kg of digestible protein. 100 kg of straw contains 32 feed units, 5.3 kg of protein, which is well eaten by small cattle (sheep). There are 51 feed units, 15.4% protein, 5.2% fat, 38.6% hydrous carbons, 7.2% ash, 22.3% cellulose per 100 kg of mass harvested for grass. Soybean is a valuable green manure and an excellent predecessor plant. Soy is a plant that loves heat and humidity. During the flowering and ripening period, it requires a higher temperature, i.e. 18-250 C. Seeds germinate at a temperature of 6-80 C. Soybean sprouts survive spring frosts around -2-50 C. This plant requires the most water during the flowering and fruiting phase. The transpiration coefficient is about 600. The flowering phase can last 15-40 days, and up to 80 days in late-ripening varieties. Soybean is a short-day plant. Other than saline and chalky soils, other soils are suitable for soybeans. Soybean grows better in soils with neutral reaction pH=6.5-7.0. Varieties regionalized in Azerbaijan: Plamya, Majesta, Umanskaya 1. Mainly well-supplied chestnut, open-chestnut gray-brown soils, etc. suitable for soybeans. Soybeans can be grown after cereals, corn and cotton in crop rotation. Soybeans should not be planted after soybeans, sunflowers, annual legumes and perennial forage legumes. If the predecessors are cereal crops, the stubble should be removed from the field as soon as the crop is harvested and the stubble should be covered. The first coating is carried out at a depth of 6-8 cm with LDQ-5 and LDQ-10 brand floaters, and if necessary, the second coating is carried out with BDT-2.5 and BDT-3 heavy disk trowels at a depth of 10-12 cm. 10-15 days after planting, the field should be plowed with PE-5-35 brand coton to a depth of 28-30 cm. After corn, the field should be disced with a two-track heavy disc trowel and then plowed to the depth of the crop layer (25-27 cm).

2. Soybean is a sensitive plant to fertilization

Experiments have determined that soybean absorbs 142 kg of N, 32 kg of P_2O_5, 35 kg of K_2O to produce a product of 20 centners. Under the main plow, N 60-90 kg, P_2O_5 60-90 kg, K_2O 30-54 kg should be given. 30% of nitrogen fertilizer should be given before sowing, and the rest as feeding twice, including 40% 2-3 weeks after the harvest, and 30% during the period of pod formation and ripening. Fertilizers RUM-5,1; RMQ-4 brand fertilizer can be applied with spreaders. Grade 1 seed should be taken for sowing. Before sowing, seeds should be treated with rhizorthorphin at the rate of 200 grams per hectare. That amount of rhizotorphin should be dissolved in 1.2 liters of water and sprayed on the tissue. For the purpose of combating bacteriosis, root rot, aminomycosis, and fusarium diseases, 1-2 kg of 70% tajigran should be applied to 1 ton of tissue at least 3-4 weeks before sowing. Application of fentouram against wireworms and bacteriosis gives good results. It is recommended to use 4.6 kg of 60% fentouram for 1 ton of fabric. The seed can be sprayed by semi-dry method in PSQI-5, PS-10, "Mobitox" machines. Depending

on the absolute mass, 50-90 kg (400-600 thousand units) of germinating seeds should be sown per hectare. Soybean can be sown with a point method with young rows, i.e. with a row spacing of 45-60 cm. The soil should be smoothed from the surface in the spring with VP-8, VPN-5,6 brand levelers or with tools made on the farm itself. Cultivation should be carried out at a depth of 6-8 cm when weeds appear. 1 week before sowing, 1.2-1.5 kg of treflan herbicide should be mixed with 200-300 liters of water and sprayed with POU, ON-400 or OBT-1 surface sprinklers and BDT-2.5 in non-irrigated fields with a head-to-head cultivator or it should be mixed into the soil at a depth of 8-10 cm with BDT-3 brand fillers. Sowing is carried out when the temperature in the sowing layer is 10-120 C. The seeds are sown in cleared areas. In non-cultivated areas, irrigation should be carried out immediately after sowing. Sowing is done with aggregates SZSSH-3,6; SPC-6M; SZ-3,6; It is carried out with SZU-3,6. Soybean has the greatest demand for moisture during the stages of mass flowering, pod formation and grain filling. Soybeans should be watered at least 4 times during the growing season for normal plant development. The first watering should be done at branching, the 2nd watering at the beginning of flowering, the 3rd watering at the formation of pods and the 4th watering at the beginning of filling. Irrigation is carried out at the rate of 500-600 m^3 per hectare by rainfall, and 700-800 m^3 per hectare by infiltration with furrows. In order to improve the water-air properties of the soil, they trowel with KRN-38 or mesh trowel one track and 1-2 tracks at the time of exit. During the vegetation period, the interstices should be loosened twice with a KRN-4.2 cultivator. During the vegetation period, spraying with a 30% emulsion of karbofos, 1-1.5 kg per hectare, and phosphamide BI-5.8 at the rate of 1 kg per hectare is carried out against the web mite and leaf-eating insects. After flowering, spraying is replaced with sulfur powder. Soybeans do not open during ripening, so there is little loss of grain. When planted for grain, soybeans should be harvested with a combine when the grain is 14-16% moisture in the full ripening phase, when the leaves are falling, the stems are drying and the beans are starting to turn yellow. The cutting device of the combine must be adjusted to cut from the bottom. In order to prevent grain breakage, the distance between the drum and the deck in CK-4A, CK-5 combines should not be less than 40 mm at the inlet and 28 mm at the outlet. The cycle of the drum should cycle 400-500 times per minute. In order to speed up ripening, desiccation is carried out in areas where fast-growing varieties are planted. In this work, 20 kg of magnesium-chlorate preporate is mixed with water and sprayed on the field when the humidity in the grain is 40-45%. If soybean straw is to be used for feed, desiccation is not carried out. If the moisture content of the collected seeds exceeds 14%, then it must be dried in the sun, and cleaned of other impurities (Mammadov, Ismayilov, 2012).

In the studies conducted by V.P. Savenkov, N.N. Khryukin and A.M. Epifanseva, soybean productivity. and its effect on quality has been studied, by plowing at a depth of 22-24 cm with turning the soil, plowing at a depth of 28-30 cm without turning the soil, cultivation at a depth of 10-12 cm, softening with a disc trowel at a depth of 6-8 cm.It was determined that high grain yield from Soybean was obtained in the main soil cultivations - 2.36 t/ha in plowing with turning the soil and 2.24 t/ha in softening without turning the soil. In the case of minimal soil cultivation, the yield decreased to 2.03 and 2.00 t/ha, respectively. The amount of protein and oil in the grain was higher in minimal tillage. High protein and fat yields were obtained in the variant with plowing without turning the soil (Savenkov *et.al.*, 2018).

According to T.S. Koshkarova, one of the most important problems in agriculture is the preservation of soil fertility and the deficit of plant protein. The main

place in solving this problem is occupied by cereals and legumes, including soy (Koshkarova, 2019).

In Volgagrad region, in steppe black soils, more grain yield and protein yield than soy was obtained in the 28-30 cm deep plowing option compared to the 5-7 cm and 18-20 cm softening options with a cultivator (Ivanov & Mordvintsev, 2014).

In the studies conducted by V.V. Kozyrev, the influence of various cultivation technologies on the productivity and quality of soybeans was studied. It was determined that a high yield was obtained when 3 t/ha of phosphogypsum fertilizer was applied per hectare and 23-25 cm of plowing was carried out and in the optimal irrigation mode. The maximum protein yield was 1.11 t/ha, the maximum fat yield was 0.58-0.65 t/ha (Kozyrev, 2014).

The effect of mineral fertilizers and herbicides on the productivity and quality of soybeans were studied in the research conducted by A. V. Shabalkin, V. A. Voronsov and Y. P. Skorochkin in the Tambov region of Russia (plowing at a depth of 25-27 cm, cultivation at a depth of 10-12 cm, plowing at a depth of 25-27 cm without turning the soil) . It was determined that high yield, protein and fat yield among the studied variants were more in the variants given mineral fertilizers $(NPK)_{60}$ and herbicide. Among the studied factors, mineral fertilizers and herbicides had a better effect on productivity. The main tillage did not have such a significant impact on productivity in isolation. Profitability increased by more than 200%, decreased by 122% due to the effect of fertilizers and 55-72% due to the combined effect of fertilizers and herbicides (Shabalkin & Vorontsov, 2019).

In the research conducted by V.A. Voronsov in the Tambov region, the effect of soil cultivation, mineral fertilizers and chemical protection agents on the piproductivity and quality of soybeans was studied. In practice, plowing at a depth of 20-22 cm, cultivation at a depth of 8-10 cm and plowing without turning the soil at 20-22 cm. In the variant plowed to a depth of 20-22 cm, in the control (without fertilizer) variant, grain yield 19.4 s/ha, protein 28.18%, protein yield 547 s/ha, in $(NPK)_{30}$ variant 20.0 s/ha, 28.37 % and 468 s/ha, 21.1 s/ha, 28.55% and 602 s/ha in the $(NPK)_{60}$ variant, 19.4 s/ha, 27.59% and 19.4 s/ha, 27.59% and 541 s/ha, 19.6 s/ha, 27.32% and 530 s/ha and 22.5 s/ha, 28.75% and 647 s/ha, 18.6 s in plowing without turning 20-22 cm of soil /ha, 27.24% and 507 s/ha, 20.2 28.23% and 570 s/ha, and 21.1 s/ha, 27.47% and 580 s/ha (Vorontsov, 2016).

The effect of soil cultivation on the yield and quality of different soybean varieties was studied. In the option with 20-20 cm plowing, protein in soybean grain is the highest in Opessa variety 36.0%, oil is 23.8%, in the option with disking at a depth of 16 cm, it is 33.9% and 24.8%, respectively, and the yield is 1.78 t/ ha and was 1.68 t/ha (10). At present, cotton and other agricultural crops are planted and cultivated on hectares of cotton in the cotton-growing regions of Azerbaijan after the barley harvest. The main purpose of the research is to study the combined effect of soil cultivation and mineral fertilizers on the yield, quality, water-physical properties of the soil, and the fertility of soybeans planted after barley harvesting on irrigated gray-brown (chestnut) soils in the Ganja-Gazakh region.

3. The object and methodology of the research

The main purpose of the research is to study the combined effect of soil cultivation and mineral fertilizers affecting the yield, quality, water-physical properties, and fertility

of soybeans planted after barley harvesting in irrigated gray-brown (chestnut) soils in the Ganja-Gazakh region. Research was carried out after barley harvesting on gray-brown (chestnut) soils irrigated with soybean Umanskaya-1 variety in Ganja RAEIM located in Samukh district of the Ministry of Agriculture of the Republic of Azerbaijan. Field experiments with 2 factors (2x4) were established after autumn barley harvest (in the 1st decade of June). Factor A: Soil cultivation: 1. Plow 20-22 cm deep; 2. 13-15 cm deep disc trowel; 3. Cultivation at a depth of 8-10 cm; Factor B: mineral fertilizer rates: 1. Control (without fertilizer); 2. $N_{30}P_{60}K_{30}$; 3.$N_{60}P_{90}K_{60}$; 4. $N_{90}P_{120}K_{90}$.

The area of the accounting section of each option is 54.0 m2 (30x1.80 m), the experiments were carried out in 3 repetitions, with 30 kg of seeds per hectare, in a 45x10 cm sowing scheme using the sowing row method. Nitrogen-ammonium nitrate 34.7%, phosphorus-simple superphosphate 18.7% and potassium-potassium sulfate 46% of mineral fertilizers in the experimental field, phosphorus and potassium 70% after barley harvest, the remaining 30% of phosphorus and potassium In feeding, during the branching phase, it was given time to leave the rows, and nitrogen once. Phenological observations were carried out on 25 plants, and agrotechnical measures were carried out in the order adopted for the region.

4. Discussion and analysis of research results

The effect of soil cultivation and mineral fertilizer rates on protein yield from soybean grain was also studied. Depending on the productivity and the amount of protein in the grain, the yield of protein also increased. The results of the study are given in the table. As can be seen from the table, the protein yield in the field cultivated at a depth of 8-10 cm was 433.1-512.3 kg/ha in the control (without fertilizer), protein yield in the $N_{30}P_{60}K_{30}$ variant was 485.5-635.6 kg/ha, and the highest protein yield was $N_{60}P_{90}K_{60}$ in the variant was 683.8-816.0 kg/ha. As the rates of mineral fertilizer increased ($N_{90}P_{120}K_{90}$), the protein yield decreased compared to the $N_{60}P_{90}K_{60}$ variant and was 595.3-726.0 kg/ha.

Table 1. Effects of soil cultivation and fertilizers on protein yield in repeated summer crops of soybean

s/s	Mineral fertilizer norms	Protein yield, kg/ha (2018)			Protein yield, kg/ha (2019)			Protein yield, kg/ha (2020)		
		8-10 sm Cultiva-tion	13-15 sm disc trowel	20-22 sm tillage	8-10 sm Cultiva-tion	13-15 sm Disk trowel	20-22 sm Tillage	8-10 sm Cultivat ion	13-15 sm disc trowel	20-22 sm tillage
1	Control (without fertilizer)	433,1	456,0	496,2	454,6	491,1	522,0	512,3	559,0	590,8
2	$N_{30}P_{60}K_{30}$	485,5	547,6	567,2	546.5	585,5	616,2	635,6	688,1	721,2
3	$N_{60}P_{90}K_{60}$	683,8	750,3	839,0	736,1	788,7	890,1	816,0	931,1	1071,2
4	$N_{90}P_{120}K_{90}$	595.3	647,8	709,4	642,7	688,1	748,9	726,0	864,0	902,8

As can be seen from the table, the protein yield in the control (without fertilizer) variant was 456.0-559.0 kg/ha, in the $N_{30}P_{60}K_{30}$ variant, the protein yield was 547.6-688.1 kg/ha, and the highest protein yield It was 750.3-931.1 kg/ha in $N_{60}P_{90}K_{60}$ variant. As the rates of mineral fertilizers increased ($N_{90}P_{120}K_{90}$), the protein yield decreased compared to the $N_{60}P_{90}K_{60}$ variant and was 647.8-864.0 kg/ha.

In the field plowed to a depth of 20-22 cm, the protein yield in the control variant (without fertilizer) was 496.2-590.8 kg/ha, in the $N_{30}P_{60}K_{30}$ variant, the protein yield was 567.2-721.3 kg/ha, and the highest protein yield was in the $N_{60}P_{90}K_{60}$ variant, 839, It was 0-1071.2 kg/ha. As the mineral fertilizer rates increased ($N_{90}P_{120}K_{90}$), the protein yield decreased compared to the $N_{60}P_{90}K_{60}$ variant and was 709.4-902.8 kg/ha.

5. Conclusion

Due to the influence of soil tillage and mineral fertilizers, the yield of soybean protein in the field cultivated at a depth of 8-10 cm was 52.4-303.7 kg/ha, and the yield of protein in the field cultivated with a disk trowel at a depth of 13-15 cm was 91.6-372.1 kg/ha. , the yield of protein in the plowed field at a depth of 20-22 cm increased by 71.0-480.4 kg/ha compared to the control (without fertilizer) variant. The highest protein yield was obtained in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers in all three soil cultivations and in the plowed field at a depth of 20-22 cm among the soil cultivations.

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