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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

STUDY OF THE SOIL CULTIVATION, FERTILIZERS EFFECT ON SOYBEAN FERTILITY AND QUALITY IN RESOWING IN THE GANJA-GAZAKH REGION

Specialty: **3103.01– General Agriculture**
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Applicant: **Huseynova Aysel Mammadbagir**

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The dissertation work was performed at Department of General Agriculture, Genetics and Selection of Azerbaijan State Agricultural University.

Scientific supervisor: Doctor of agrarian sciences,
associate professor
Hasanali Asad Aslanov

Official opponents: The member of ANAS, doctor of biological
Garib Shamil Mammadov

PhD in agrarian sciences,
associate professor
Rahil Gurban Hasanov

PhD in agrarian sciences,
associate professor
Izzet Atakhan Talibov

Dissertation Council at BFD 4.28 of the Supreme Attestation Commission under the President of The Republic of Azerbaijan operating at Agrarian Science and Innovation Center, Research Institute of Crop Husbandry

Chairman of the Dissertation Council: Doctor of agrarian sciences, professor _____ **Zaur Muzadil Hasanov**

Scientific secretary of the Dissertation council: PhD in agrarian sciences, associate professor _____ **Mahsati Mikayil Alakbarova**

Chairman of the scientific seminar: Corresponding member of ANAS, doctor of agricultural sciences, professor
_____ **Ibrahim Hasan Jafarov**

GENERAL CHARACTERISTIC OF THE WORK

The relevance of the topic and the degree of its elaboration. Being an important fat-protein plant, soybean has a wide range of applications. Currently, up to 1000 food products, including oil, yogurt, milk, cheese, etc., are produced from soybean (***Gilisine hispida L.)*** is prepared. Soy products are quickly digested by the human body. When soy protein is added to protein obtained from other plants, its nutritional value increases even more. Soy products are excellent dietetics for diabetics, obese people and vegetarians. In humans, it is very effective in the treatment of cardiovascular and vascular diseases, and in the regulation of blood cholesterol.[1]

Soybean cultivation area is 100 million ha in the world. 90 countries are involved in soybean production. In recent years, in the world, more than 200 million tons of soy products have been produced. In the main product producer countries indicators are as follows: 35-40% of the cultivated area in the United States, 20% in Brazil, 12% in Argentina, 13% in China, and 8% in India. These countries consider for 95% of the total soybean production in the world. Soybeans are cultivated more in Canada, Indonesia, Paraguay, Russia, Ukraine, Europe, Africa, etc. Soy is considered a very profitable crop in Russia. Soybean seeds contain 38-40% protein and 18% fat. After extracting oil from soybeans, the remaining part is used as animal feed.[2] In the experimental area, during the growing season, irrigation was carried out 4 times with furrows at the rate of 700-800 m^3.

In the research conducted by A.P. Khudiyev and G.Y. Mammadov in the Ganja-Gazakh region, it was calculated that 5418 kg of feed units and 903 kg of digestible protein were obtained from

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[1] Гаврилин Д.С., Полевщиков С.И. Оценка отечественных и зарубежных сортов сои по содержанию белка в зерне, полученном в условиях Тамбовской области // М.: Кормопроизводство, №8, 2014. – С. 26-28.

[2] Решетников А.А., Соколов С.М. Из опыта возделывания скороспелой сои // Научно – производственный журнал «Зернобобовые и крупяные культуры» 2014, №2(10), с.35-39.

soybeans cultivated in pure crops.[3]

The effect of irrigation methods and fertilizer rates on the soybean yield grown in the field was he subject of the studies carried out by Sh.H.Ahmedov, M.Y.Rzayev and Z.M.Abdullayeva at the Agricultural Research Institute in Absheron conditions. According to the authors, there are wide opportunities for the soybeans cultivation and the purchase of high grain and green mass products in Azerbaijan. Soybean is a heat-loving plant, the temperature required for its development and ripening is 1700-32000^{0}C. The optimum temperature for seed germination should be 20-22^{0}C .Furthermore, the demand for heating is high during the soybean flowering and bean germination period. In addition to spring crops, it is economically very profitable to cultivate soybeans in the stubble after barley harvest. Frequent sowing on irrigated lands makes it possible to get additional grain and fodder products from a single area, and to make effective use of meliorative facilities. At this process the soil is enriched with organic substances, its salinization is prevented, wind erosion problems and weed control are completely solved.

Stubble crops cultivation conducted in large farms increases the possibility of more efficient use of labor force, irrigation water, irrigation networks, agricultural machinery and equipment. [4]

The global ecological processes occurring in nature requires new tillage technologies and fertilization systems that save energy carriers for different agro-ecological regions and plants in our republic. Increasing grain-leguminous plants fertility in modern times is one of the important issues of agricultural science.

Ganja- Gazakh region considers one of the crucial places in the production of agricultural products in our republic. Therefore, taking into account the above-mentioned, in the market economy, in a time

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[3] Xudiyev, Ə.P., Məmmədov, Q.Y. Qarğıdalı və soyanın yemçilikdə əhəmiyyəti // ADAU-nun Elmi Əsərləri, Gəncə: ADAU nəşriyyatı, 2012, №3, s.76-78.

[4] Əhmədov, Ş.H., Rzayev, M.Y., Abdullayeva, Z.M. Suvarma üsullarının və gübrə normalarının kövşənlikdə becərilən soyanın məhsuldarlığına təsiri // Gəncə Dövlət Universiteti, "Müasir kimya və biologiyanın aktual problemləri" mövzusunda beynəlxalq elmi konfransın materialları (12-13 may 2016). Gəncə: GDU nəşriyyatı, 2016, IV hissə, 240-244.

when the prices of fuel and lubricants are high, by saving energy resources, maintaining soil fertility, food in the region, the importance of soybean as a food, fodder and technical plant from the point of view of safety, in order to increase its fertility and quality ,the study of soil cultivation and mineral fertilizers effectiveness is one of the actual problems.[5]

Goals and objectives of the study. Taking into account the relevance of the problem, the main purpose of the research is to study the combined effect of soil cultivation and mineral fertilizers impact on the fertility, quality, water-physical properties of soybean planted after barley harvest on irrigated (gray-brown) soils under conditions of Ganja- Gazakh region.

To achieve the goal of the research, the following tasks are envisaged:

- determination of soil and climate conditions in the area during the research years;
- determination of soil water-physical, agrochemical properties;
- determination of soil cultivation and mineral fertilizer dosages that affect the weeding occurring in the field and the water-physical properties change of the soil;
- to determine the effect of soil cultivation methods and mineral fertilizer doses on the development, growth and structural components of the soybean plant, on the yield and quality index obtained from a single area;
- determination of soil cultivation methods and mineral fertilizer doses impact on economic efficiency.

Research methods. In accordance with the programme and methodology of the dissertation, the soybean variety Umanskaya-1 was selected as the object of our research. The purpose was achieved through experience. In the research work, the analysis of plant and soil samples conducted in the laboratory and agrotechnical works carried out in the field were carried out according to the existing methodology.

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[5] Hüseynova, A.M. Qərb bölgəsində təkrar əkinlərdə torpaq becərmələrinin və mineral gübrə normalarının soyanın alaqlanmasına təsiri // Azərbaycan Texnologiya Universiteti, "Elmi Xəbərlər" məcmuəsi, Gəncə, 2021, №1/34, s. 109-114.

Irrigation technology is considered one of the most important agrotechnical measures. It cannot be replaced by any agrotechnical measures. Before irrigation, the first loosening is carried out, the proper amount of mineral fertilisers is applied. In the research work, the analysis of plant and soil samples conducted in the laboratory and the agrotechnical work conducted in the field were carried out in accordance with the existing methodology.

In the soil samples brought for analysis: pH using a potentiometer device, total humus according to the method of I.V. Tyurin and granulometric composition according to the method of N.A. Kaczynski, absorbed bases according to the method of K.K. Hedroys, absorbed ammonia according to the method of D.P. Konev, activated phosphorus according to the method of B.P. Machigi, Determination of nitrate nitrogen by Grandval-Liajou, total potassium based on Smith's method, exchangeable potassium was determined according to P.B. Protasov's flame photometer method, total phosphorus and nitrogen were determined by the method of K.E.Ginzburg, G.M.Sheglova, V.S.Zaytsev's simplified calculation and N.A. Kaczynski's modification, and the soil moisture content was determined by drying in a 105°C thermostat. The amount of protein, fat, cellulose and ash in soybean grain was determined by generally accepted methods. The accuracy of the obtained results was confirmed through mathematical calculations.[6]

The main provisions put into defense.

-Physical-chemical, water-physical and agrochemical properties of the experimental area soil ;

- The effect of soil cultivation and mineral fertilizer dosages on soybean development phases on moisture content, volume mass and total porosity change in 0-10; 10-20; 20-30 cm soil layers.

-The effect of soil cultivation methods and mineral fertilizer doses on the field weeding in connection with the soybean development phases, soybean height, branching, leaf surface and structural indicators;

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[6]Доспехов, Б.А. Методика полевого опыта / Б.А.Доспехов. - М.: Агро¬пром-издат, - 1968. – 335 с.

-The effect of soil cultivation and mineral fertilizers on soybean yield, quality, protein and fat yield;

- Determination of economic efficiency.

Scientific novelty of the study.

In the research work, for the first time, the effective norms of soil cultivation and mineral fertilizers under soy were determined in the conditions of Ganja- Gazakh region after barley harvest, soil fertility increased, quality and fertility indicators escalated.

The theoretical and practical significance of the research. It was ascertained that soil cultivation and mineral fertilizers have an significant effect on the crop quality and soybeans yield in repeated summer crops after the barley harvest. The highest indicators were 1479.6 AZN/ha and the level of profitability was 138.2% when plowing by turning the soil at a depth of 20-22 cm, in the $N_{60}P_{90}K_{60}$ mineral fertilizer rate.

Approbation and application.

Research workn results was presented at the International scientific-practical conference on "The Main Problems of Quality Assurance of University-Industrial Relations" held at the Department of General Agriculture, Genetics and Selection of Azerbaijan State Agricultural University; At the International scientific-practical conference held at the Azerbaijan Technological University on the topic "The main problems of quality assurance of university-industrial relations" (Ganja, 2020), at the International scientific-practical conference held in the Russian Federation on the topic "Advances in Science and Technology" (XXXVII International Scientific-Practical Conference), Research and Publishing Center «Actualnots.RF», Moscow, Russia June 15, 2021), at the International Scientific Symposium (The XXXII International Scientific Symposium) held in Kars-Eskishehir (Republic of Türkiye) on the topic "Turk's Victory: from CHANAKKALE to KARABAKH" November, 2022), was discussed at the conference on "Education and research activities in the new era: realities and challenges" (December 16-17, 2022) at Mingachevir State University.

Based on the results of the research work, 13 scientific works reflecting the main propositions of the dissertation were published, 9

of them were articles (4 in journals included in the international summarizing and indexing database), and 4 were conference materials.

The result of the experiment was applied in 2021 on an area of 3 ha in the village of Balakurd, which is part of the village municipality of Kizil Hajili of Goranboy district. The result of the application was 1405.0 AZN/ha when plowing by turning the soil at a depth of 20-22 cm and at the $N_{60}P_{90}K_{60}$ mineral fertilizers rate.

The name of the organization in which the dissertation work is performed.

Dissertation work was carried out at Azerbaijan State Agricultural University.

The volume of the structural units of the dissertation in isolation and the total volume with a sign.

The thesis consists of an introduction, five chapters, conclusions, recommendations for implications, a list of 206 references and an appendix. There are 5 figures, 20 tables and appendices. In the content of the dissertation, the introduction is 5 pages of 9123 characters, the first chapter is 19 pages of 35725 characters, the second chapter is 12 pages of 23058 characters, the third chapter is 17 pages of 29824 characters, the fourth chapter is 26 pages of 49928 characters, the fifth chapter is 27 pages of 47693, the conclusion is 3 pages, 4210 characters, 1 page of recommendations for production, 547 characters, and the list of 206 references is 22 pages, 34179 characters. The total volume of dissertation is 168 pages, covers 266924 characters in the total capacity (183231 characters).

Main Contents of The Study

The relevance of the topic and the general characteristics of the dissertation work are indicated in the introduction.

In **Chapter I**, with the name of "Literature Review" indicates effects of soil cultivation, sowing time, plant density, mineral fertilizers in, other agrotechnical measures on the water-physical properties of the soil, soil fertility, height and development of soybeans, structural indicators, fertility and quality etc. in in the research conducted abroad and in our Republic by many authors.

Conducted research authenticates that the study of soil cultivation and mineral fertilizer norms is considered relevant in connection with the food security, with a view to the efficient use of the available land resources, harvesting twice a year from the same area, after the barley harvest, it is necessary to obtain high quality grain products in the conditions of Samukh region.

Chapter II implies "Importance, history, distribution, botanical description, biological characteristics and cultivation of soybeans". Scientific studies show that, depending on the species, legumes can collect between 100 and 400 kg of nitrogen per hectare in their stems. For this reason, legumes play a crucial role in agriculture by increasing soil fertility. By pressing the green mass of legumes into the soil in sandy and loamy soils that are poorly supplied with nutrients, nitrogen as well as ash elements are increased.

In addition, the water-holding capacity of the soil and soil quality are improved. Green manure improves nutrition, water and air conditions on hard soils of our country. For the production of siderates, it is necessary to select a plant suitable for soil and climatic conditions. When sowing, the time, method and rules of planting should be specified. If they are observed from each hectare, you can get up to 400 centners of green mass. Because of this, the yield of grain crops increases by 3.5-3.7 times, potatoes - by 2-3 times. At the beginning of the bean wilting stage, the green mass of grain and legume crops is planted and ploughed. To obtain a siderate, sowing time is carried out in spring, summer or autumn.

Here is general information about the plants included in the cereal legumes group, the main and by-product of legumes and the nutrients extracted from the soil, the demand for fertilizers, soil cultivation, soybean in various types of cultivation, duration and norms of sowing, significance, history, growth, botanical description, biological characteristics, etc.

Chapter III is devoted to "Soil-climate conditions of the researched region, object and methodology of the research, physical-chemical, water-physical and agrochemical properties of the experimental area soils".

According to statistical data, chestnut soils in our republic occupy 2200.6 thousand hectares (25.5%). They are spread along the foothills and in the low-mountain belt in a rather wide strip up to 200 metres high. This territory is characterised by dry desert plantation. According to their properties chestnut soils are divided into light, dark and mixed soils. Chestnut can be found in places where soils of semi-desert and dry steppe meet, in places with high temperature (up to 130°C) and insufficient humidity. The annual precipitation of 250 mm is completely insufficient to cover evaporation and water consumption. Such soil is characterised by deep salinisation, alkaline reaction and low humus content (about 2%). The upper part of the zone is characterised by a lot of chestnut and dark chestnut soils. This area is characterised by high humidity (annual precipitation 300-500 mm) and semi-annual temperature of 12.50C. The reaction is slightly alkaline, humus content is from 3 to 5%.

The soils of the northwestern foothills of the Lesser Caucasus are divided into the following types in accordance with the soil cultivation conditions: mountain-forest brown soils, mountain-meadow, mountain-gray-brown, mountain-black, meadow-chestnut, gray-brown, alluvial-meadow, gray soil, reed, brown semi-desert or Subasar meadow forest. Our research area is located in the territory of Samukh district, in the plain of the Small Caucasus mountains. If we look at the average multi-year indicators during the vegetation period, it is obvious that the amount of rains and weather conditions have changed minimally from the average multi-year indicator during the years of research.

Field experiments were conducted in 2018-2020 in the territory of Samukh district, at the Ganja Regional Agrarian Science and Innovation Center of the Ministry of Agriculture of the Republic of Azerbaijan, in irrigated gray-brown (chestnut) soil as replanting after harvesting soybeans with Umanskaya-1 variety of barley.

The experiment is 2-factorial and was conducted after the autumn barley harvest (after the 1st decade of June).

Factor A: Soil cultivation: 1. Cultivation at a depth of 8-10 cm; 2. 13-15 cm deep disc trowel; 3. Plow to a depth of 20-22 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. $N_{90}P_{120}K_{90}$.

Experiments were conducted with inter-row cultivation method, in 3 repetitions, with the area of 54.0 m^2 (30x1.80 m) in the registration section for each option, 45x10 cm planting scheme, 30 kg of seeds taken per hectare.

The following forms of mineral fertilizer were used for the experimental area: potassium-potassium sulfate form (46%), nitrogen-ammonium nitrate form (34.7%), phosphorus-simple superphosphate form (18.7%). From mineral fertilizers, it was considered appropriate to give N fertilizer once at the exit time, and P and K fertilizers for the most part 70% before sowing, and the remaining 30% during the branching period at feeding process. Agrotechnical measures were carried out according to the rules established for the area. In total, phenological observations were carried out on twenty-five plants.

The result of the field experiment, leaf surface, fertility, precision in the experiment, mathematical analysis of correlation relations, economic efficiency were conducted by V.N. Peregudov [145, p.131-132], B.A. Dospexov [88, p.127-129], P.N. Konstantinov [7, p. 214-216] and Baranov N.N [59, p.150] methods.

Before commencment of the experiment, after barley harvesting, the main physical-chemical, water-physical and agrochemical parameters of the soil were studied. Reffering to absorbed bases, the total was 28.6 mg/eq in the 0-30 cm layer, and it decreased to 20.5 mg/eq in the 60-100 cm layer. The amount of physical clay is 53.1-52.8% along the profile, and the amount of silt is 24.6-22.5%.

Moisture in the 0-30 cm layer of the soil is 16.3%, specific gravity is 2.65 g/cm^3, bulk density is 1.23 g/cm^3, total porosity is 53.58%, and accordingly, in 60-100 cm is 22.5 %, 2.73 g/cm^3, 1.32 g/cm^3, 49.46% .

The agrochemical analyzes conducted on the gray-brown (chestnut) soil demostrate that according to the gradation adopted in the republic (A.N. Gulahmadov, F.H. Akhundov, S.Z. Ibrahimov 1980), these soils are not rich enough in nutrients. In order to ensure soil fertility and high grain yield from soybeans planted on these lands,

it is crucial to apply mineral fertilizers twice a year, specially after the barley harvest.

Chapter IV is entitled "Effect of soil cultivation and mineral fertilizer norms on the change of water-physical properties of the soil and weeding of the field".

The effect of soil cultivation and mineral fertilizer norms under soy on the change of moisture content (%), volume mass (g/cm^3) and total porosity (%) at the beginning and end of vegetation in 0-10, 10-20 and 20-30 cm soil layers was also studied. The highest indicators among soil cultivation were plowed at a depth of 20-22 cm and mineral fertilizers were obtained in the norm of $N_{60}P_{90}K_{60}$.

Scientific research has found that soils with higher moisture content are more suitable for cultivation because they eliminate excess moisture and create a healthy water-air balance in the seedbed. Additional agronomic practices used on well-tilled soils include topdressing, irrigation, successive planting and other practices that increase productivity. Mechanical cultivation is mainly used to control weeds and maintain soil moisture in cultivated fields.

Soil cultivations and mineral fertilizer rates had an effect on the amount of weeds in the field compared to the control-fertilizer-free variant.

Soil cultivation and mineral fertilizer rates also affected the amount of weeds in the field compared to the control-fertilizer-free variant. The number of weeds in 1 m^2 in each of the 8-10 cm and 13-15 cm soil cultivation options was significantly higher than in the area cultivated at a depth of 20-22 cm in terms of development phases, this is related to the shallow plowing of the soil, weed seeds remaining on the soil surface and not falling into the deep layers of the soil. The highest amount of weeds was observed in the cultivated area at a depth of 8-10 cm, and the least amount was observed in the plowed area at a depth of 20-22 cm.[7]

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[7] Hüseynova, A.M. Qərb bölgəsində təkrar əkinlərdə torpaq becərmələrinin və mineral gübrə normalarının soyanın alaqlanmasına təsiri //Azərbaycan Texnologiya Universiteti, "Elmi Xəbərlər" məcmuəsi, Gəncə, 2021, №1/34, s. 109-114.

Chapter V is dedicated to "The effect of soil cultivation, mineral fertilizer norms on the growth, development, fertility, quality and economic efficiency of soybeans".

In the ripening phase of the grain, the height was 60.5-61.7 cm in the field cultivated at a depth of 8-10 cm ,2-65.0 cm, 69.5-71.0 cm in the plowed area at a depth of 20-22 cm, and 66.0-67.8 cm respectively; the highest indicator was observed in the $N_{60}P_{90}K_{60}$ variant; It was 70.6-71.5 cm and 78.4-79.5 cm.[8]

The number of branches in the plowed field at a depth of 20-22 cm is 12.5-14.5, and the highest number is 12.6-14.7 in the $N_{60}P_{90}K_{60}$ variant; It was 13.6-14.7 and 15.5-17.5 (unit). As the doses of mineral fertilizers increased, the number of branches decreased by 10.6-11.2, 12.3-13.8, and 13.7-18,8 respectively, in the $N_{90}P_{120}K_{90}$ norm of mineral fertilizers in the background of all three soil cultivations.[9]

As a consequence of the different rates effect of mineral fertilizers in each of the soil cultivations, the leaf surface of one plant increased in comparison with the control (without fertilizer) variant.[10] Conducted studies indicate that soil cultivation and mineral fertilizer rates have a significant effect on the number of pods and grains produced by one plant, on the mass of grain produced by one plant and on the mass of 1000 grains.

The indicators studied in the field plowed to a depth of 20-22 cm in the comparison to the fields cultivated at a depth of 8-10 cm and plowed with a disk trowel at a depth of 13-15 cm demonstrate even higher results in each of the options. Hereby, in the control (without fertilizer) variant, the number of beans shaped from 1 plant mass is 20.6-22.3 units, the number of grains shaped from 1 plant is 41.2-44.1

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[8] Aslanov, H.Ə., Hüseynova, A.M. Torpaq becərmələrinin və mineral gübrələrin soyanın yay əkinlərinin boyuna təsiri // Azərbaycan Texnologiya Universiteti Elmi Xəbərlər, 2020, № 2(33), s.105-109.

[9] Hüseynova, A.M. Torpaq becərmələrinin və mineral gübrələrin soyanın yay əkinlərinin budaqlanmasına təsiri // Azərbaycan Texnologiya Universiteti Elmi Xəbərlər, 2020, № 1(32), s.105-108.

[10] Hüseynova, A.M. Torpaq becərmələrinin və mineral gübrələrin soyanin yarpaq səthinə təsirinin öyrənilməsi // The XXXII International Scientific Symposium "Turk's Victory: from CHANAKKALE to KARABAKH", November 2022, s.484-485.

units, the number of grains shaped from 1 plant mass is 7.0-7.5 grams and the mass of 1000 grains was 122.4-123.8 grams.

The highest indicators are 33.8-35.8 pods from one plant in the $N_{60}P_{90}K_{60}$ variant; the number of grains formed from one plant is 65.1-70.0 units; the mass of the grain formed from one plant is 11.4-12.2 grams; The mass of 1000 grains is 130.6-132.8 grams, and in the case of the $N_{90}P_{120}K_{90}$ variant with a high rate of mineral fertilizers, the number of pods formed from one plant is 29.5-31.4 units compared to the $N_{60}P_{90}K_{60}$ variant; the number of grains formed from one plant is 58.8-61.2 units; The weight of one seed from one plant was 10.0-10.4 grams and the weight of 1000 seeds was 128.2-130.2 grams.[11]

The effect of soil cultivation and mineral fertilizer rates on soybean grain yield is indicated in Figure 1.

As it is apparent from the picture, in the control (without fertilizer) option, the grain yield of soybeans was 13.7 c/ha on average over 3 years in the field cultivated at a depth of 8-10 cm, while the grain yield increased significantly compared to the control (without fertilizer) option when different rates of mineral fertilizer were applied. Consequence of this, in the variant $N_{30}P_{60}K_{30}$ 16.0 c/ha, an increase of 2.3 c/ha or 17.0%, and the highest grain yield in the variant $N_{60}P_{90}K_{60}$ is 21.0 c/ha, an increase of 7.3 c/ha or 53 .0% obtained.

As the rate of mineral fertilizer increased ($N_{90}P_{120}K_{90}$), productivity decreased compared to $N_{60}P_{90}K_{60}$, corresponding to 18.7 c/ha, the increase was 5.0 c/ha or 36.0%. The grain yield per 1 kg of NPK was 1.92 kg in the $N_{30}P_{60}K_{30}$ variant, 3.48 kg in the $N_{60}P_{90}K_{60}$ variant, and 1.67 kg in the $N_{90}P_{120}K_{90}$ variant. The accuracy of the experiment was P=1.50-2.41%, E=0.24-0.41 c/ha, the difference between the variants was three or more times higher than the E indicator. This proves the accuracy of the experiment.

In the control (without fertilizer) variant of the control (without fertilizer) in the 13-15 cm deep disc trowel, the soybean grain yield was 14.6 c/ha on average over 3 years, as a result of the application of different rates of mineral fertilizers, 13-15 cm deep the grain yield in

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[11] Гусейнова А.М. Влияние обработка почв и минерального удобрений на структуру урожая летный посадок сои // М.: Аграрная наука, №, с.

the field treated with disc harrow increased significantly compared to the control (without fertilizer) option. Therefore, in $N_{30}P_{60}K_{30}$ option 17.4 c/ha, an increase of 2.8 c/ha or 19.0%, and the highest grain yield in $N_{60}P_{90}K_{60}$ option is 23.0 c/ha, an increase of 8.4 c/ha or 58 was 0%. As the rates of mineral fertilizers increased ($N_{90}P_{120}K_{90}$), the yield decreased relative to the $N_{60}P_{90}K_{60}$ variety and was 20.6 c/ha, 6.0 c/ha or 41.0%, respectively. The grain yield per 1 kg of NPK was 2.33 kg in the $N_{30}P_{60}K_{30}$ variant, 4.00 kg in the $N_{60}P_{90}K_{60}$ variant, and 2.00 kg in the $N_{90}P_{120}K_{90}$ variant. The accuracy of the experiment was P=2.00-2.73%, E=0.34-0.60 c/ha, and the difference between the variants was three or more times higher than the E indicator.

In the field plowed to a depth of 20-22 cm, a higher grain yield was obtained in each of the variants than in both soil cultivations. In the control (without fertilizer) option, the grain yield of soybean was 15.4 c/ha on average over 3 years, as a result of the application of different rates of mineral fertilizers, the grain yield increased significantly compared to the control (without fertilizer) option. Thus, in the variant $N_{30}P_{60}K_{30}$ 18.0 c/ha, an increase of 2.6 c/ha or 17.0%, and the highest grain yield in the variant $N_{60}P_{90}K_{60}$ is 25.5 c/ha, 10.1 c/ha or 66, 0% received. As the rates of mineral fertilizers increased ($N_{90}P_{120}K_{90}$), productivity decreased relative to the $N_{60}P_{90}K_{60}$ variant and was 21.8 c/ha, 6.4 c/ha or 42.0%, respectively. The grain yield per 1 kg of NPK was 2.20 kg in the $N_{30}P_{60}K_{30}$ variant, 4.81 kg in the $N_{60}P_{90}K_{60}$ variant, and 2.13 kg in the $N_{90}P_{120}K_{90}$ variant. The accuracy of the experiment was P=1.80-2.94%, E=0.34-0.58 c/ha, and the difference between the options was three or more times higher than the E indicator.[12]

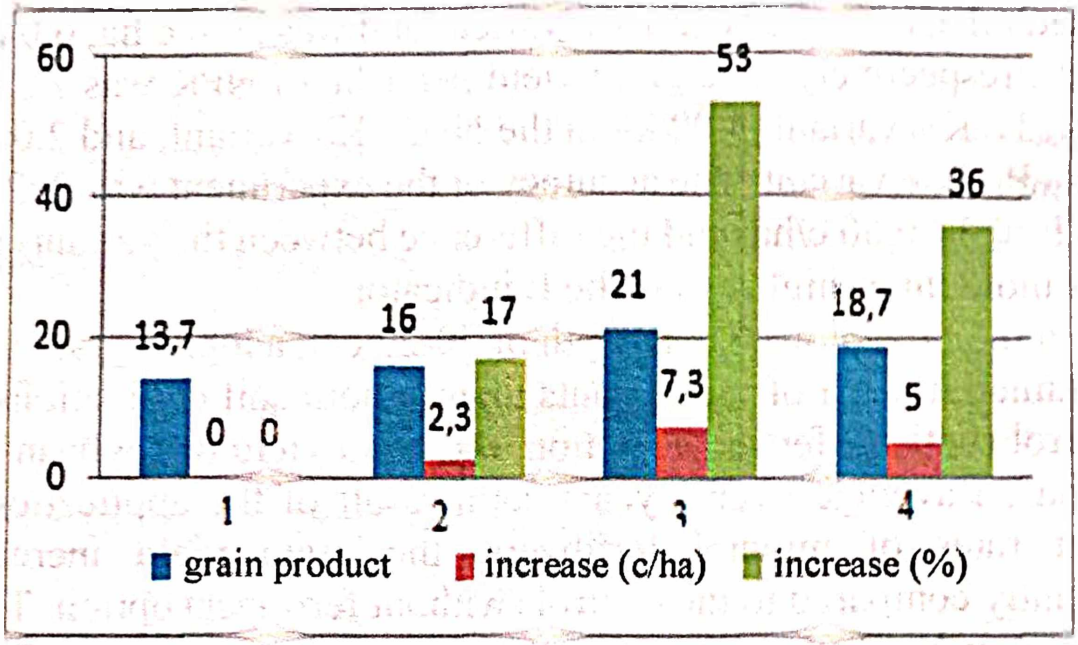
The effect of soil cultivation and mineral fertilizer rates on the quality of soybeans was also studied.

8-10 cm deep cultivation in the control (without fertilizer) protein 34.10-34.18%, fat 15.01-15.13%, cellulose 4.18-4.25% and ash 3. 71-3.78%, as a result of the application of mineral fertilizers different doses, the quality indicators were significantly higher than

[12] Гусейнова А.М. Влияние минеральных удобрений и обработки почвы на уро¬жайность летних посадок сои (Западный Азербайджан) // Бюллетень науки и практики /Bulletin of Scienceand Practice.Москва-№7-2021 с.84-89.

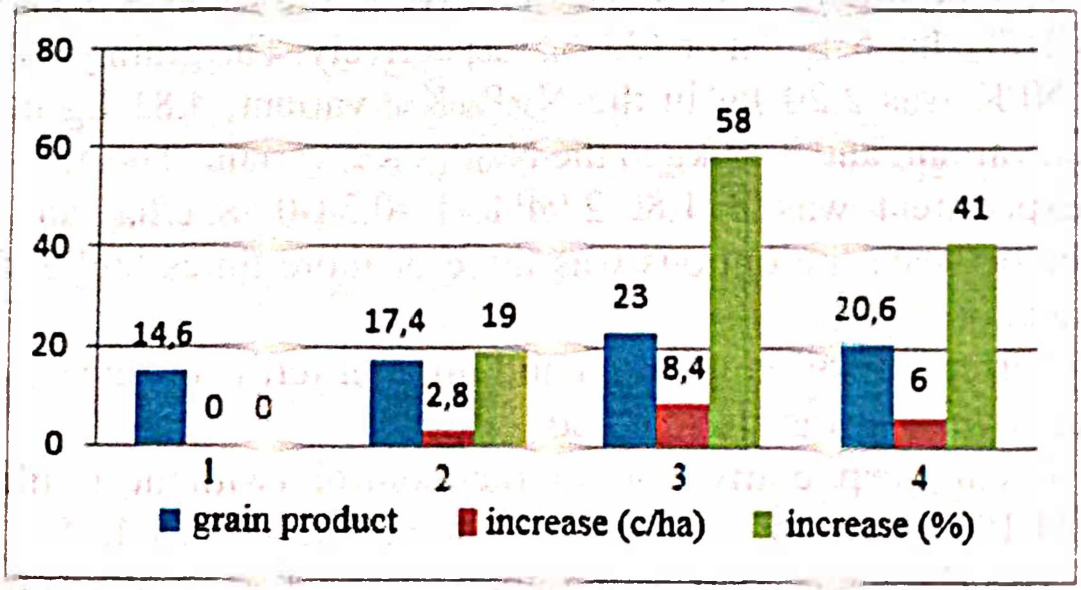
the control (without fertilizer) option. Therefore, in the $N_{30}P_{60}K_{30}$ variant, protein was 34.68-34.81%, fat was 15.21-15.38%, cellulose was 4.45-4.57%, and ash was 3.93-4.04%.

a) Cultivation at a depth of 8-10 cm



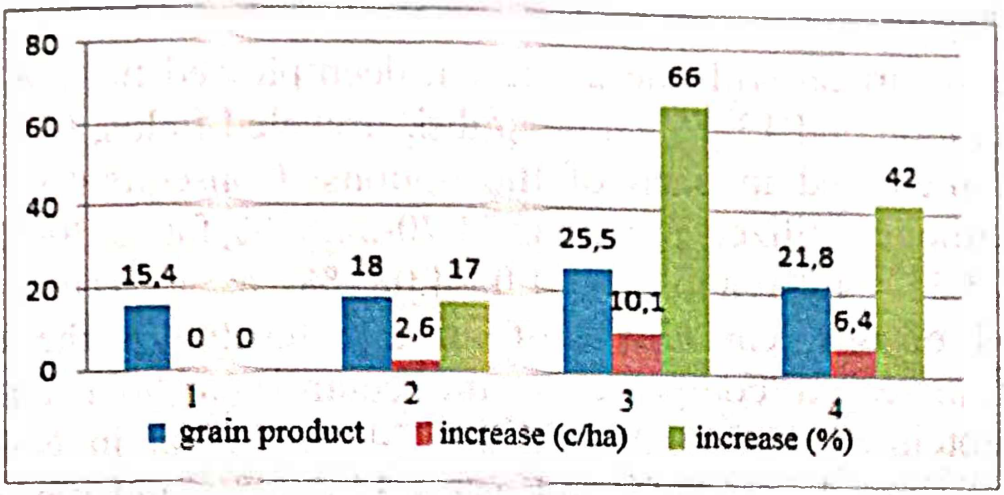
E = 0.24-0.41 c/ha, P = 1.50-2.41%

b) 13-15 cm deep disc trowel



E = 0.34-0.60 c/ha, P = 2.00-2.73%

c) Plow at a depth of 20-22 cm



E = 0.34-0.58 c/ha, P = 1.80-2.94%

Figure 1. Effects of soil cultivation and mineral fertilizer rates on soybean grain yield (average over 3 years) 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 highest quality indicators are protein 35.43-35.59% in $N_{60}P_{90}K_{60}$ variant; fat 15.63-15.80%; cellulose 5.30-5.42% and ash 4.65-4.76% were observed. As the rates of mineral fertilizers increase ($N_{90}P_{120}K_{90}$), the quality indicators decrease in comparison with the $N_{60}P_{90}K_{60}$ variant, protein 35.02-35.12%; fat 15.45-15.55%; cellulose was 5.01-5.13% and ash was 4.05-4.18%.

Quality indicators increased in the area cultivated with a disk trowel at a depth of 13-15 cm compared to the area cultivated at a depth of 8-10 cm. As a consequence, in the control (without fertilizer) protein is 34.28-34.34%, fat is 15.18-15.26%, cellulose is 4.25-4.34% and ash is 3.83-3.88 %, as a result of the application of different norms of mineral fertilizers, the quality indicators were increased compared to the control (without fertilizer) variant, protein 34.88-35.06%, fat 15.48-15.61%, cellulose 4, 57-4.69% and ash 4.10-4.20%, and the highest indicators are protein 35.73-35.85% in $N_{60}P_{90}K_{60}$ variant; fat 15.88-16.01%; cellulose was 5.43-5.57% and ash was 4.84-4.93%. As the rates of mineral fertilizers increase ($N_{90}P_{120}K_{90}$), the quality indicators decrease compared to the $N_{60}P_{90}K_{60}$ variant, protein 35.40-

35.65%; fat 15.65-15.73%; cellulose was 5.15-5.25% and ash was 4.35-4.41%.

In comparison with the 20-22 cm deep plowed field, 8-10 cm deep cultivation and 13-15 cm deep disk troweled fields, the quality indicators increased in each of the options. Consequently, in the control (without fertilizer) protein is 34.70-34.80%, fat 15.30-15.45%, cellulose 4.35-4.46% and ash 4.03-4.08 %, as a result of the application of different norms of mineral fertilizers, the quality indicators increased compared to the control (without fertilizer) variant, protein 35.45-35.62%, fat 15.77-15.97%, fat in $N_{30}P_{60}K_{30}$ variant, cellulose 4.71-4.86% and ash 4.34-4.41%, and the highest indicators are protein 36.48-36.63% in $N_{60}P_{90}K_{60}$ variant; fat 16.21-16.40%; cellulose was 5.65-5.81% and ash was 5.10-5.18%. As the rates of mineral fertilizers increase ($N_{90}P_{120}K_{90}$), the quality indicators decrease relative to the $N_{60}P_{90}K_{60}$ variant, protein 36.01-36.18%; fat 15.93-16.01%; cellulose was 5.25-5.45% and ash was 4.63-4.75%.

The effect of soil cultivation and mineral fertilizer rates on protein and fat yield from soybeans was also determined. Depending on the fertility, the amount of protein and fat in the grain, the yield of protein and fat also increased.

In the field cultivated at a depth of 8-10 cm, the protein yield was 433.1-512.3 kg/ha in the control variant (without fertilizer), and the highest protein yield was 683.8-816 kg/ha in the $N_{60}P_{90}K_{60}$ variant. was 683,8-816,0 kq/ha.

In the control (without fertilizer) variant, the protein yield was 456.0-559.0 kg/ha, and the highest protein yield was 750.3-931.1 kg/ha in the $N_{60}P_{90}K_{60}$ variety.

In the field plowed to a depth of 20-22 cm, the protein yield in the control (without fertilizer) variant is 496.2-590.8 kg/ha, and the highest protein yield it has been 839.0-1071.2 kg/ha in the $N_{60}P_{90}K_{60}$ variant.

In the field cultivated at a depth of 8-10 cm, the oil yield was 190.6-226.1 kg/ha in the control variant (without fertilizer), and the highest oil yield was 301.7-361.3 kg/ha in the $N_{60}P_{90}K_{60}$ variant.

In the control (without fertilizer) variant, the oil yield was 201.9-248.3 kg/ha, and the highest oil yield was 333.5- It was 414.2 kg/ha.

In the field plowed to a depth of 20-22 cm, the oil yield in the control (without fertilizer) variant is 218.8-261.1 kg/ha, in the $N_{30}P_{60}K_{30}$ variant, the oil yield is 252.3-322.0 kg/ha, the highest oil yield was 372.8-478.5 kg/ha in $N_{60}P_{90}K_{60}$ variety. As the norms of mineral fertilizers increased ($N_{90}P_{120}K_{90}$), the yield of oil decreased in comparison to the $N_{60}P_{90}K60$ variant and amounted to 313.8-399.5 kg/ha.[13]

In the production of agricultural products, obtaining scientifically sound results and applying them in the production of increasing the level of profitability is one of the most important tasks facing agrarian science.

The effect of soil cultivation and mineral fertilizer rates on the economic efficiency of soybeans is indicated in Figure 2 on average over 3 years.

Depending on the grain yield of soybeans and mineral fertilizer norms, the net income from one hectare is 615.0-1049.6 AZN/ha in the background cultivated at a depth of 8-10 cm, to the level of profitability and changed between 61.8-100.0%. The highest indicators in the $N_{60}P_{90}K_{60}$ variant of mineral fertilizers were net income of 1049.6 AZN/ha , the cost of 1 quintal product was 50.0 AZN, and the profitability level was 100.0%. At the reduced rates of mineral fertilizers $N_{30}P_{60}K_{30}$, the cost of one centner of grain is 59.1 AZN, net income is 654.5 AZN/ha, the level of profitability is 69.2%, and at the increased rates of mineral fertilizers $N_{90}P_{120}K_{90}$, the cost of one centner of grain is 61 8 AZN, the net income was 714.2 AZN/ha and the profitability level was 61.8%.

In the 13-15 cm deep disc harrow, the cost of one quintal was lower, and the level of net income and profitability was higher in all variants compared to the 8-10 cm deep cultivation background. Depending on the yield of soybeans and mineral fertilizer norms, the net income from one hectare area varied from 695.0 to 1239.6 AZN/ha, and the profitability level varied from 76.7 to 117.0%. The

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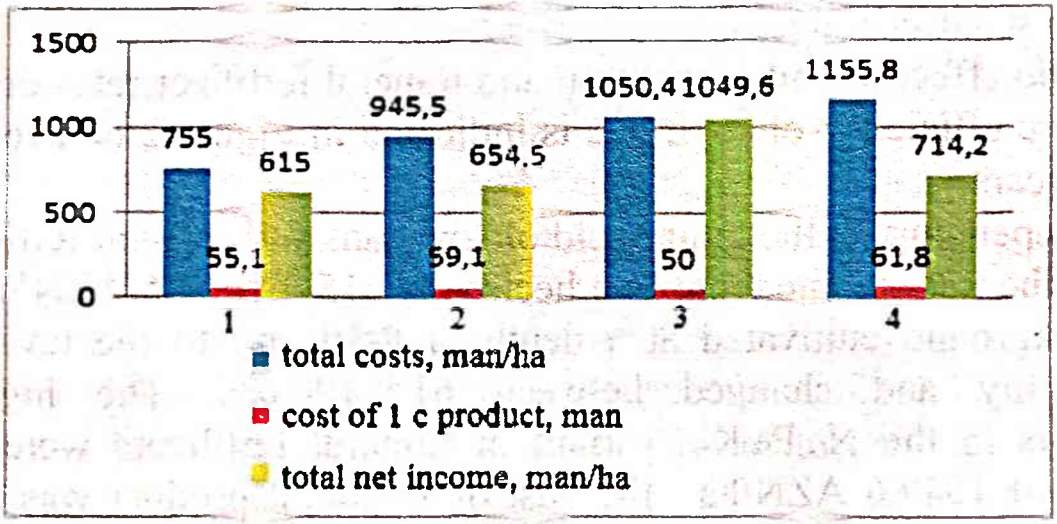
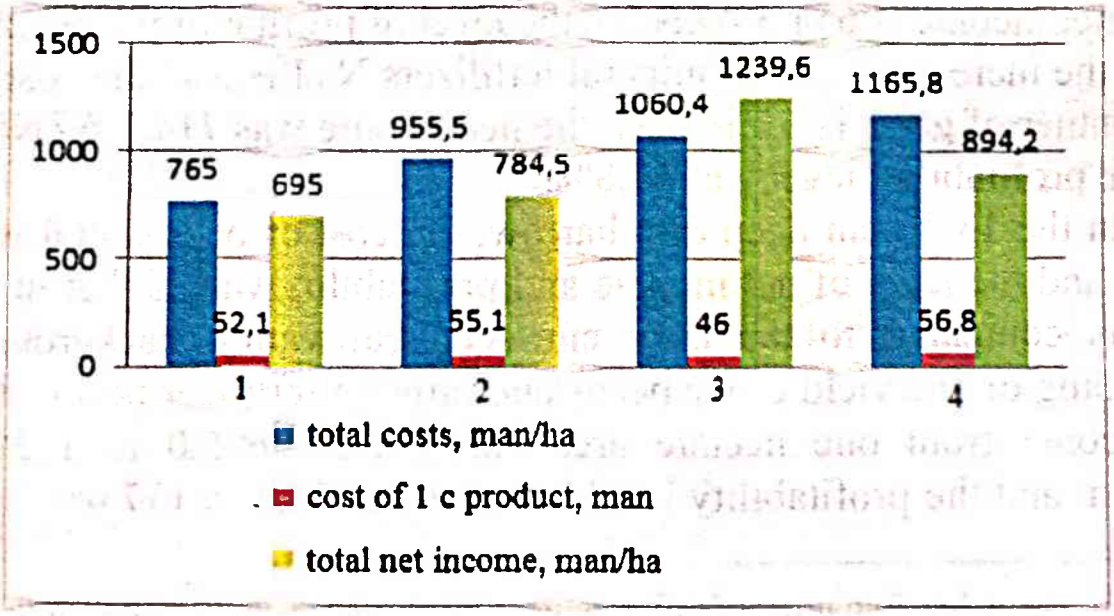
[13] Гусейнова А.М. Влияние обработка почв и минерального удобрений на летние посадки сои на выход масла // «Advances in Science and Technology» XXXVII Международная научно-практическая конференция. Research and Publishing Center «Actualnots.RF», Moscow, Russia June,15, 2021, **с.9-13.**

highest indicators are in the 8-10 cm cultivation background, the net income of mineral fertilizers in the norm of $N_{60}P_{90}K_{60}$ is 1239.6 AZN/ha, the cost of 1 quintal product is 46.1 AZN, and the level of profitability is 117.0%. The cost of one centner of mineral fertilizers in the reduced rates of $N_{30}P_{60}K_{30}$ is 55.0 AZN, the net income is 784.5 AZN/ha, the profitability level is 82.1%, and the cost of one centner of $N_{90}P_{120}K_{90}$ in the increased rates is 56.6 AZN, the net income is 894, 2 AZN/ha and the level of profitability was 76.7%.

a) Cultivation at a depth of 8-10 cm



b) 13-15 cm deep disc trowel



c) Plow at a depth of 20-22 cm

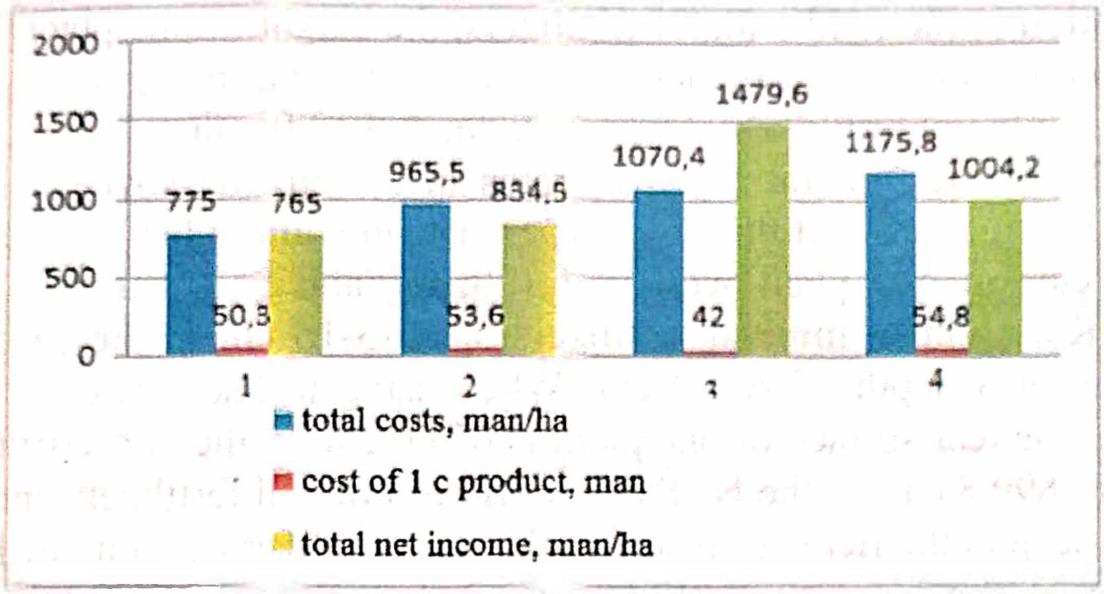


Figure 2. Effect of tillage and mineral fertilizers on soybean economic efficiency (2018-2020, average of 3 years): 1. Control (without fertilizer), 2. $N_{30}P_{60}K_{30}$, 3.$N_{60}P_{90}K_{60}$, 4. $N_{90}P_{120}K_{90}$

CONCLUSION

1. It was determined that when plowing at a depth of 20-22 cm in replanting of soybeans, mineral fertilizers in the 0-30 cm soil layer at the rate of $N_{60}P_{90}K_{60}$ at the end of the vegetation period are applied with a disc trowel at a depth of 13-15 cm and 8-10 cm compared to the deep-cultivated background, the moisture content increased by 3.8-4.6%, the total porosity increased by 0.75-1.39%, and the volume mass increased by 0.02. -0.04 g/cm^3 decreased.

2. Soil cultivation and mineral fertilizer rates had a significant effect on the length and branching of soybeans during the development phases. As the mineral fertilizer rates increased, soybean height and branching increased in all three soil cultivations. The maximum height and branching were observed in the full ripening phase and when plowing at a depth of 20-22 cm, the height of one plant without fertilizer was 70.3 cm, the number of branches was 11.4 units, 79.0 cm in the norm of mineral fertilizers $N_{60}P_{90}K_{60}$ and 16.4 pieces, 13-15 cm deep with a disk trowel, in the version without fertilizer, the height of one plant is 64.6 cm and the number of branches is 9.7, in the norm of

mineral fertilizers $N_{60}P_{90}K_{60}$, 71.0 cm and 14.2 pieces, 8 -10 cm depth cultivation in the field without fertilizers, the height of one plant was 61.1 cm, the number of branches was 8.8 units, and in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers, it was 66.0 cm and 13.0 units.

3. As the mineral fertilizer rates increased, the soybean leaf surface increased in all three soil types. The maximum leaf surface is 705.7 cm^2 in one plant without fertilizers, and 958.4 cm^2 in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers, and 13-15 cm in the case of plowing at a depth of 20-22 cm. When using a disc trowel in the garden, the leaf surface of one plant is 674.0 cm^2 in the non-fertilizer version, 899.8 cm^2 in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers and 8-10 cm deep in the field cultivated in the non-fertilizer version, the leaf surface of the plant was 612.0 cm^2, and in the norm of mineral fertilizers $N_{60}P_{90}K_{60}$ it was 819.0 cm^2.

4. Soil cultivation and mineral fertilizer norms also affect the cultivation of the field. The highest amount of weeds was observed in the cultivated background at a depth of 8-10 cm, and the least in the background plowed at a depth of 20-22 cm, 10.3-20.7 pieces/m^2 in the ripening phase of grain in the field cultivated at a depth of 8-10 cm, 8.5-18.0 pieces/m^2 in the field cultivated with a disk trowel at a depth of 13-15 cm, at the depth of 20-22 cm, it was 6.0-11.0 units/m^2.

5. The number of beans produced per plant, the number of grains produced per plant, the mass of grain produced per plant and the mass of 1000 grains were higher when plowing at a depth of 20-22 cm compared to other soil cultivations. The highest indicators were observed in the norm of mineral fertilizers $N^{60}P^{90}K^{60}$ and were 34.6 units, 45.1 units, 11.9 grams and 131.6 grams respectively.

6. The higher grain yield than soybeans is 15.4 c/ha in the non-fertilizer version when plowing at an average depth of 20-22 cm for 3 years, 25.5 c/ha in the norm of mineral fertilizers $N_{60}P_{90}K_{60}$, the increase is 10% compared to the non-fertilizer version ,1 c/ha or 66.0% was purchased. In the case of other soil cultivations, it is reduced to a depth of 13-15 cm with a disk trowel, respectively 14.6 c/ha and 23.0 c/ha, 8.4 c/ha or 58.0%, 8-10 cm and 13.7 c/ha and 21.0 c/ha, 7.3 c/ha or 53.0% in the area with deep cultivation.

7. Due to the influence of mineral fertilizers, in the field cultivated at a depth of 8-10 cm, the protein content of soybean grain is 0.58-1.38%, oil is 0.20-0.67%, cellulose is 0.27-1.17%, ash is 0. 22-0.98%, protein 0.60-1.51%, fat 0.30-0.75%, cellulose 0.32-1.23%, ash 0.27-1.05%, protein 0.74-1.83%, fat 0.47-0.95%, cellulose 0.36-1.35 in the plowed field at a depth of 20-22 cm %, ash increased between 0.31-1.10% compared to the control (without fertilizer) variant. The highest quality indicators were observed in the $N_{60}P_{90}K_{60}$ ratio of mineral fertilizers in all three soil cultivations, and in the field plowed to a depth of 20-22 cm within the soil cultivations.

8. Due to the effect of mineral fertilizers, the yield of soybean protein in 52.4-303.7 kg/ha, oil yield 22.3-135.2 kg/ha, in the area cultivated at a depth of 8-10 cm, protein yield in the field plowed with a disc harrow at a depth of 13-15 cm is 91.6-372.1 kg/ha, oil yield is 41.1-165.9 kg/ha, protein yield is 71 in the field plowed at a depth of 20-22 cm. 0-480.4 kg/ha, oil yield increased from 33.5-217.4 kg/ha compared to the control (without fertilizer) variant. The highest protein and oil yield was obtained in all three soil cultivations in the $N_{60}P_{90}K_{60}$ norm of mineral fertilizers, and in the soil cultivations, the field was plowed to a depth of 20-22 cm.

9. The study of the effect of soil cultivation and mineral fertilizer rates on the economic efficiency of repeated summer plantings of soybeans emphasizes that the highest indicators are the optimal rates of mineral fertilizers when plowing by turning the soil at a depth of 20-22 cm. In the $N_{60}P_{90}K_{60}$ variety, the net income was 1479.6 AZN/ha and the profitability level was 138.2%.

PRODUCTION RECOMMENDATIONS

In the Ganja- Gazakh district, the following recommendations were offered to the production in order to obtain a high quality grain yield from soybeans and preserve soil fertility in replanting after barley harvesting in the irrigated gray-brown soils:

1. Plowing at a depth of 20-22 cm by turning the soil after harvesting barley;

2. Providing mineral fertilizer at the rate of $N_{60}P_{90}K_{60}$;

3. From the mineral fertilizers, it was considered appropriate to apply N fertilizer 1 time, P and K fertilizers 70% before sowing, and the remaining 30% during feeding and it was considered appropriate to apply it to the inter-row during the branching period.

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