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ABSTRACT

Of the dissertation for the degree of Doctor of Philosophy

STUDY OF THE EFFECT OF SOIL CULTIVATION AND NUTRITION CONDITIONS ON WHEAT PRODUCTIVITY IN A SHORT CROP ROTATION IN THE NOT-IRRIGATED CONDITIONS OF SOUTH MUGHAN

Specialty: **3103.07- Plant-growing**

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Applicant: **Huseyn Mirzaga Feyzullayev**

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The dissertation work has been carried out at the Jalilabad Regional Experimental Station of the Research Institute of Crop Husbandry of the Ministry of Agriculture of the Republic of Azerbaijan.

Scientific supervisor: Doctor of Philosophy on agrarian sciences, assistant profesor
Mazahir Yahya Rzayev

Official opponents: Doctor of agrarian sciences, professor
Hasanali Asad Aslanov

Doctor of Philosophy on agrarian sciences, assistant professor
Khuraman Tofig Abbasov

Doctor of Philosophy on agrarian sciences
Afag Gulam Gasımova

Dissertation Council at FD 1.29 of the Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Research Institute of Crop Husbandry of the Ministry of Agriculture.

Chairman of the Dissertation Council:
Doctor of agrarian sciences, professor
Jalal Shamil Mammadov

Scientific Secretary of the Dissertation Council:
Doctor of philosophy on agrarian sciences, assistant professor
Sevda Kamal Hajiyeva

Chairman of the scientific seminar:
doctor of agrarian sciences, professor
Maarif Almadat Yusifov

GENERAL DESCRIPTION OF THE RESEARCH

The actuality and degree of using of the topic. As the most important factor limiting crop production, drought is one of the most serious problems in the world, which reduces the productivity and quality of plants by adversely affecting the physiological processes that take place when the plant is not supplied with moisture or poorly supplied. In soil the moisture reserve varies depending on the predecessor, soil cultivation and nutritional conditions.

It is known that in the dry, non-irrigated conditions of South Mugan, due to high summer temperatures and extremely low rainfall, the soil remains dry after the harvest of predecessors (autumn wheat and pea). This significantly increases its density which leads to the formation of large clods of earth when plowing deep in such areas and these clods of earth prevent the quality of sowing without breaking down during pre-sowing cultivation. Seedlings obtained after sowing become sparse and weak and cause a significant reduction in productivity. Therefore, in such areas there is a need for surface cultivation, not deep plowing. In this case, large clods of earth that interfere with sowing are not formed, massive and uniform seedlings are obtained.

Although suitable predecessors increase the productivity and quality of the next crop, it is necessary to use mineral and organic fertilizers to achieve better results.

Thus, one of the most actual issues of the day is the development of proper cultivation methods and the recommendation to farms using modern technologies to obtain high and qualitative products from wheat in dry, non-irrigated conditions.

Goals and objectives of the study. The main purpose of the study is to determine the optimal soil cultivation and nutritional conditions after properly selected predecessors in the cultivation of wheat in the non-irrigated conditions of South Mugan. In order to achieve the set goal, the following tasks are considered appropriate to carry out:

- Studying of the impact of basic cultivation methods on the development of winter wheat in the non-irrigated conditions;

- Determining the impact of cultivation factors on the viability of winter wheat by determining the amount of plants that survived up to the harvest, overwintering of plants and germination of seeds in the field against the background of predecessor, soil cultivation and nutritional conditions;

- Investigation of the impact of the studied factors on the weeding of the field;

- Study of the effect of soil cultivation and nutritional conditions applied after different predecessors on the development of the root system in winter wheat varieties;

- Determination of the impact of predecessors, soil cultivation and nutritional conditions in autumn wheat varieties on structural elements, productivity and grain quality in dry, non-irrigated conditions;

- Determining a cost-effective cultivation method;

The methods of the research. The 3-factor (2x3x3) field experiment is presented in the follwing scheme:

Factor A: Predecessors

1. Autumn wheat;
2. Pea.

Factor B: Soil cultivation

1. Traditional (at a depth of 20-22 cm ploughing + disc + harrow);
2. With a heavy-disc harrow at a depth of 10-12 cm twice disking;
3. With a heavy-disc harrow at a depth of 10-12 cm once disking.

Factor C: Nutritional conditions

1. Unfertilized;
2. $N_{60}P_{60}$ + 10 tons of manure
3. $N_{90}P_{60}K_{45}$

After each predecessor, the experimental area was divided into 9 parts with an area of 50.4 m^2 (3.6m x 14m), with a distance of 0.6m, and these also were placed in 4 repetitions with a distance of 2m in turn. 3 fertilizer norms were studied in each cultivation variant, as well as Barakatli 95 hard and Gobustan soft wheat varieties were studied.

Standard methods were used during the research. Thus, the viability of plants was determined by counting plants in 2 rows (0.8m × 0.3m × 4 = 1m^2) marked in length of 0.8m in 4 different places on full

germination, early spring and repetitions before harvest[1]. Also, the phases of development were determined according to F.M.Cooperman[2], and the amount of weeds in a single area (0.25 m^2 × 4) was determined by counting weeds in 4 different places on the iterations using a frame of 0.25 m^2 to determine the weeds of the area[3]. The analysis of the structural elements of the product was carried out on sheaf samples taken from 1 m^2, and the factual grain yield was determined in practice by the mass of grain harvested directly by the combine on each bed[1]. After harvesting, root residues were studied at a depth of 0-20 cm and 20-40 cm in the soil by the Stankov method[3]. The amount of protein and gluten in the grain was determined by Keldal and Yermakov's washing method, respectively[4, 5]. The dispersion analysis of the results obtained by calculating the profitability was carried out using the computer program SPSS 26.

The main theses of the defense. The main theses of the research are as follows:

- Influence of soil cultivation and nutritional conditions on the development of wheat depending on its predecessor;

- The effect of basic cultivation methods on plant viability (seed germination; the number of plants that survive the winter and survive up to the harvest);

- The importance of predecessors, soil cultivation and nutritional conditions in the fight against weeds;

- The important role of cultivation methods in the distribution

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[1] Musayev A. C., Huseynov H.S., Mammadov Z.A. Methodology of field experiments on research works in the field of selection of grain-cereal plants. / - Baku: Muallim – 2008, - 87 p., p. 28-29, p. 36-41, p. 55-60

[2] Cooperman F. M. Morphophysiology of plants. / Moscow: High school, 1977. – 288 p., p. 9

[3] Hajiyev C.A. Practical exercises from agriculture / Huseynov M.M., Alizada F.H., Mammadova K.Y. – Gandja: 2009 – 105p., 63-64p., 4-5p., 10-14p., 35-37p.

[4] Pleshkov B.P. Practical work on plant biochemistry / Moscow: Ear – 1985, - 255p., 7-9p.

[5] Ermakov A.I. Methods of biochemical research of plants / Arasimovich V.V., Ikonnikova M.I., Yarosh N.P., [and others] – Leningrad: Ear – 1972, - 456p., 267-269p.

of the root system at different depths in the background of predecessors, soil cultivation and nutritional conditions;

- Increase of structural indicators of the product and productivity under the influence of the main cultivation factors, as well as improvement of grain quality;

- Determining a cost-effective cultivation method with increasing profitability against the background of properly selected predecessors, soil cultivation and nutritional conditions.

Scientific novelty of the research. For the first time in our three-factor (2 × 3 × 3) field experiment at the Jalilabad Regional Experimental Station in South Mugan, using Barakatli 95 hard and Gobustan soft wheat varieties optimal nutritional conditions and soil cultivation have been identified by minimizing soil cultivation depending on the predecessor and replacing some mineral fertilizers with organic fertilizers in order to obtain high quality grain.

Theoretical and practical significance of the research. Deep plowing of the soil leads to further fragmentation of structural aggregates which increases the amount of dust fractions, reduces the structural quality of the soil and reduces the amount of water-resistant aggregates. In heavy granulometric soils, deep plowing produces more clods of earth which reduces the quality of sowing. Also, the level of profitability decreases because deep plowing is a more costly operation. In our study, high results were obtained in the cultivation of wheat varieties studied in the option of minimizing land cultivation after both predecessors.

Along with properly selected soil cultivation, the application of organic and mineral fertilizers also allows to obtain higher yields. Thus, when some mineral fertilizers are replaced with organic fertilizers, along with the increase in yield, the structural condition of the soil improves and its fertility increases. The results of the study also showed that the best results from the fertilizer norms applied in the soil cultivation we studied in both wheat varieties were obtained by replacing part of the mineral fertilizer with 10 tons of manure per hectare.

Approbation and application of the work. The results of the research had been duscussed at the Scientific Reporting Meetings of

the Research Institute of Crop Husbandry, at the Multidisciplinary Republican Scientific-Practical Conference on "Heydar Aliyev's Legacy in the Development Strategy of Azerbaijan" dedicated to the 98th anniversary of the national leader H.A.Aliyev (Baku, 2021), at the X International Scientific Conference on "Achievements and Challenges" (Baku, 2021), at International Scientific-Practical Conference on "Modern Problems of Livestock and Innovative Concepts" dedicated to the 90th anniversary of the Animal Husbandry Research Institute and the 120th anniversary of Academician F.Malikov (Baku, 2021)), at the International scientific-practical conference on "Soil and ecological problems of agrocenoses and their solutions" (Baku, 2021), at the international scientific-practical conference on "Global science and innovation 2021: Central Asia" (Kazakhstan, 2021), at International Scientific-Practical Conference on "Innovative technologies are the basis for modernization of agriculture" dedicated to the anniversary of Professor N.P.Krivko (Russia, 2022).

The effect of predecessors, soil cultivation and nutritional conditions on the productivity and quality of wheat in the dry conditions of South Mugan was studied and the optimal option was determined and applied to various farms, totally in the area of 15 hectares.

Name of the organization where the dissertation work is carried out. The dissertation work was carried out on the territory of Jalilabad Regional Experimental Station of the Research Institute of Crop Husbandry of the Ministry of Agriculture of the Republic of Azerbaijan.

The total volume of the dissertation with a sign, indicating the volume of the structural units of the dissertation separately. The dissertation work consists of an introduction, 4 chapters, results, recommendations to farmers, bibliography and appendices. The work consists of a total of 182 pages of computer records, including 53 tables and 42 figures, with a total volume of 307.588 characters (excluding pictures, tables, references, and appendices, 201.435 characters). Thus, the introduction consists of 18.040 characters with 9 pages, the first chapter consists of 51.750 characters with 24 pages, the second chapter consists of 19.159 characters with 11 pages, the third

chapter consists of 12.035 characters with 7 pages, the fourth chapter consists of 96.775 characters with 70 pages, also the results consists of 2.963 characters per page, industry recommendations consists of 713 characters with 1 page and used literature consists of 40.335 characters with 22 pages. References were made to 190 literary sources using local and foreign literatures, including 90 local, 63 Russian and 37 English-language publications.

MAIN CONTENT OF THE WORK

The introduction provides a justification for the relevance of the research, the goals and objectives of the research, the main provisions of the work defended, scientific novelty and practical significance.

The first chapter provides a summary of the literature. This chapter consists of 3 sub-chapters: "Predecessors", "Soil Cultivation" and "Nutritional Conditions". The sub-chapters refer to local and foreign literature sources related to various scientific research conducted in the country and around the world. Based on this literature, an extensive analysis of the topic was conducted.

The second chapter describes the soil and climatic conditions of the region. Thus, the region has a complex relief, located on the border of the Kur-Araz lowland, in the north-western part of the Alashar-Burovar range. Types and subtypes of gray-brown soils predominate in the region[6]. Annual precipitation varies from north to south between 350-500 mm. The average annual temperature is 14.3^0C, and the average monthly temperature is $26\text{-}27^0$C. The hottest months are July and August, when the maximum temperature reaches $38\text{-}39^0$C. The total active temperature during the vegetation stage is $4300\text{-}4400^0$C. The number of frost-free days is 250 days. Atmospheric sediments occur mainly in autumn and winter[7].

[6] Mammadov G.S. Socio-economic and ecological bases of effective use of land resources of Azerbaijan / Baku: Science – 2007, - 854p., p. 364, p.373, p. 379, p. 397, p. 399

[7] Madatzade A.A. Natural synoptic-climatic seasons of Transcaucasia (on the example of Azerbaijan). Questions of the geography of Azerbaijan. / - Baku: - 1964, - 235 p., p. 138-147

According to the pH of the soil in the soil and subsoil layers in 2018-2020, the experimental field soils have a weak acid reaction. According to the total amount of humus, the area planted by both predecessors was of medium quality soils in the region, and its amount in the 0-30 cm layer was 2.16-2.29%, respectively. Also, the amount of mobile phosphorus and exchangeable potassium in this layer varied between 11.9-13.4% and 270-332% depending on the predecessor, as a result of which both soils were poorly supplied with mobile phosphorus and well supplied with exchangeable potassium.

Due to the amount of calcium carbonate and the degree of salinity, these soils are non-saline with little or no carbonation.

Global climate change in the world is also reflected in the agrometeorological indicators of research years. Thus, the average monthly temperature has risen compared to the perennial average, and the amount of rainfall has fallen significantly. In the growing season of 2019-2020, due to low rainfall, the plants were provided with little moisture, resulting in low productivity. However, in 2018-2019, as a result of mild weather and high rainfall compared to other years, high and qualitative products were obtained that year.

Chapter three. This chapter provides information on the research method, observation, analysis, measurement and calculations, as well as the biological characteristics of the studied wheat varieties.

Thus, in the three-factor (2 × 3 × 3) field experiment installed at the Jalilabad Regional Experimental Station in the non-irrigated conditions of South Mugan, it has been studied autumn wheat and pea as a predecessor, traditional cultivation from soil cultivations (at a depth of 20-22 cm plough + disc + harrow), at a depth of 10-12 cm at twice disking with a heavy-disc harrow, at a depth of 10-12 cm at once disking with a heavy-disc harrow, and $N_{60}P_{60}$ + 10 tons of manure və $N_{90}P_{60}K_{45}$ fertilizer norms in the background of nutritional conditions unfertilizered.

Chapter Four. In this chapter, it is given the influence of soil cultivation and nutritional conditions, which are included in the cultivation factors depending on the predecessors, on a number of elements studied in wheat varieties.

4.1. Influence of soil cultivation and nutritional conditions on seed germination. The sowing of Barakatli 95 hard and Gobustan soft wheat varieties was carried out at the rate of 4 mln and 5 mln sprouting grains per hectare, respectively. After wheat predecessor the field germination in Barakatli 95 hard wheat variety in the option of no fertilizer at a depth of 10-12 cm at twice disking with heavy-disc harrow was 328 pieces/m^2 (82.0 %), 254 pieces/m^2 (63.5%) in traditional cultivation, 294 pieces/m^2 (73.5%) at a depth of 10-12 cm at once disking with a heavy-disc harrow, and after pea predecessor that was 345 pieces/m^2 (86.3%), 268 pieces/m^2 (67.0%), 318 pieces/m^2 (79.5%). And after wheat predecessor in Gobustan soft wheat variety the field germination was 417 pieces/m^2 (83.4%) at a depth of 10-12 cm at twice disking with a heavy-disc harrow, 322 pieces/m^2 (64.4%) in traditional cultivation, 376 pieces/m^2 (75.2%) at a depth of 10-12 cm at once disking with a heavy-disc harrow, and after pea predecessor that was 436 pieces/m^2 (87.2%), 344 pieces/m^2 (68.8%), and 406 pieces/m^2 (81.2%) respectively.

In the Barakatli 95 hard wheat variety, depending on the feeding conditions for each predecessor, the field germination at a depth of 10-12 cm in the option of twice disking with a heavy-disc harrow was 328-360 pieces/m^2 (82.0-90.0 %), 254-281 pieces/m^2 (63.5-70.3%) in traditional cultivation, 291-331 pieces/m^2 (73.5-82.8%) at a depth of 10-12 cm at once disking with a heavy-disc harrow. These indicators in Gobustan wheat variety were observed as 417-454 pieces/m^2 (83.4-90.8%), 322-361 pieces/m^2 (64.4-72.2%), 376-419 pieces/m^2 (75.2-83.8%) respectively. No sharp differences in field germination were observed against the background of feeding conditions. However, a relatively good indicator was observed after each predecessor against the background of $N_{60}P_{60}$ + 10 tons of manure for both varieties, which amounted to 338-454 pieces/m^2 (84.5-90.8%). Based on the obtained results, the dispersion analysis was performed and it was found that the effect of all three factors studied on field germination of seeds in Barakatli 95 hard and Gobustan soft wheat varieties was significant at the probability level of 0.01. According to Duncan's criterion, after pea predecessor the highest field germination for both varieties was at

twice disking at a depth of 10-12 cm with a heavy-disc harrow in the background of $N_{60}P_{60}$ + 10 tons of manure applied.

4.2. Influence of soil cultivation and nutritional conditions on wintering of varieties. After autumn wheat predecessor the number of plants that survived the winter in Barakatli 95 hard wheat variety was 208 pieces/m^2 in traditional cultivation, 208 pieces/m^2 at a depth of 10-12 cm at twice disking with a heavy-disc harrow, 248 pieces/m^2 at a depth of 10-12 cm at twice disking with a heavy-disc harrow. After pea predecesor this indicator was observed to be 227, 303 and 272 pieces. In the background of feeding conditions, high indicators were observed in the option of $N_{60}P_{60}$ + 10 tons of manure for each predecessor which is 234-255 pieces in traditional cultivation, 305-337 pieces at a depth of 10-12 cm at twice disking with a heavy-disc harrow, 271-304 pieces at a depth of 10-12 cm at twice disking with a heavy-disc harrow.

These indicators were relatively high in Gobustan soft wheat variety. Thus, after the predecessors of wheat and pea changed between 277-305 pieces in traditional cultivation, between 373-395 pieces at a depth of 10-12 cm at twice disking with a heavy-disc harrow, between 331-364 pieces at a depth of 10-12 cm at twice disking with a heavy-disc harrow, and relatively high indicator was observed in the background of $N_{60}P_{60}$ + 10 tons of manure after both predecessors. In this background the highest indicator was 439 pieces at a depth of 10-12 cm at twice disking with a heavy-disc harrow after pea predecessor.

As a result of the dispersion analysis for both varieties, it was determined that the effect of each factor is significant at the probability level of 0.01. According to Duncan's criterion, winter-resistance of plants was higher after pea predecessor in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm and $N_{60}P_{60}$ + 10 tons of manure.

4.3. Influence of soil cultivation and nutritional conditions on field weeding. In traditional cultivation under Barakatli 95 hard wheat variety (at a depth of 20-22 cm ploughing + disc + harrow) after wheat predecessor while the amount of weeds is 32.7-54.6 piec-

es/m^2 after pea predecessor these indicators changed between 28.6-49.5 pieces/m^2. In the option of disking the soil once at a depth of 10-12 cm with a heavy-disc harrow after wheat and pea predecessors the amount of weeds was 37.4-59.7 pieces/m^2 and 34.0-54.8 pieces/m^2 respectively. Relatively low weeding was observed in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow that this was 26.8-48.0 pieces/m^2 and 22.2-43.0 pieces/m^2 respectively. The lowest weeding after pea predecessor was in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm. While high weeding was observed in the option of $N_{60}P_{60}$ + 10 tons of manure (this indicator is not at the level of economic loss) in all three cultivation in the background of nutritional conditions, relatively low weeding was in the option of $N_{90}P_{60}K_{45}$. While relatively low weeding was observed on the first ten days of March and April under Gobustan soft wheat variety after pea predecessor in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm and the fertilizer $N_{90}P_{60}K_{45}$, highest weeding was in the background of disking the soil once with a heavy-disc harrow at a depth of 10-12 cm and $N_{60}P_{60}$ + 10 tons of manure that this was on the given options 18.7-3.5 pieces/m^2 and 58.9-14.4 pieces/m^2 respectively.

In the SPSS 26 computer program, a three-factor dispersion analysis of the results for 2019-2021 was conducted and it was found that the impact of factors on the amount of weeds under both varieties in the first ten days of March and April was significant at a probability level of 0.01. According to Duncan's criterion, on the first ten days of March and April the lowest weeding was observed in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm and $N_{90}P_{60}K_{45}$ after pea predecessor.

4.4. Influence of soil cultivation and nutritional conditions on the amount (viability) of surviving plants during the harvesting period. The amount of plants that survived the harvesting period after wheat predecessor in Barakatli 95 hard wheat variety in traditional cultivation in unfertilized background (at a depth of 20-22 cm plough + harrow + disc) was 173 pieces/m^2, at a depth of 10-12 cm at

twice disking with a heavy-disc harrow was 241 pieces/m^2 and at a depth of 10-12 cm at 1 time disking was 212 pieces/m^2. After pea predecessor these indicators were 194 pieces/m^2, 269 pieces/m^2 and 238 pieces/m^2 respectively. After wheat predecessor in the background of nutritional conditions in traditional cultivation was 173-209 pieces/m^2, at a depth of 10-12 cm at twice disking with a heavy-disc harrow was 241-282 pieces/m^2, at a depth of 10-12 cm at once disking with a heavy-disc harrow was 212-245 pieces/m^2, after pea predecessor that was 194-233 pieces/m^2, 269-318 pieces/m^2 and 238-282 pieces/m^2 respectively. The best indicator was observed after each predecessor to be in the background of $N_{60}P_{60}$ + 10 tons of manure.

These indicators were various in Gobustan soft wheat variety of autumn wheat as well. Thus, in traditional cultivation after wheta and pea predecessor was 243-273 pieces/m^2, 337-389 pieces/m^2 and 295-343 pieces/m^2, after pea predecessor was 273-324 pieces/m^2, 362-424 pieces/m^2 and 330-384 pieces/m^2. The best indicators were observed after pea predecessor and here the best indicators were observed to be in the background of $N_{60}P_{60}$ + 10 tons of manure.

The three-factor dispersion analysis of the obtained results was performed in SPSS 26 software package. Thus, the effect of all three factors studied on the number of surviving plants during the harvest period is significant at a probability level of 0.01. According to Duncan's criterion, in camparison with other variants after pea predecessor the number of plants that survived up to the harvesting period was higher in unit area at a depth of 10-12 cm in the option of disking the soil twice and $N_{60}P_{60}$ + 10 tons of manure.

4.5. Influence of soil cultivation and nutritional conditions on the development of wheat varieties. Under favorable environmental conditions, plants complete their developmental phases. Depending on the variant on both varieties studied, the total vegetation period was various with differences between the developmental phases. Thus, after pea predecessor in Barakatli 95 hard wheat variety the general vegetation period was optimal in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm in comparison with other two cultivation varieties. After pea predeces-

sor the potential development period of variety was observed in the option of disking the soil twice with a heavy-disc harrow at a depth of 10-12 cm in the background of $N_{60}P_{60}$ + 10 tons of manure and the total vegetation period was 220 days. In this variant, the total vegetation period of Gobustan soft wheat variety was optimal compared to other variants, and this period was completed in 223 days.

4.6. Influence of soil cultivation and nutritional conditions on the structural elements of the product. In Barakatli 95 variety according to cultivation variety the length of the ear which is one of the elements of the ear, the number of grain and the mass of the grain from one ear are 5.6-8.4 cm, 26-47 pieces and 0.96-1.66 gr respectively. In Gobustan wheat variety was 6.1-9.3 cm, 29-50 pieces and 1.03-1.69 gr respectively. After pea predecessor the highest indicators for both varieties were observed in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow and $N_{60}P_{60}$ + 10 tons of manure that this was 8.4 cm, 47 pieces and 1.66 gr in Barakatli 95 variety, and in Gobustan variety this was determined to be 9.3 cm, 50 pieces and 1.69 gr respectively. The number of productive stems in a single field, the mass of 1000 grains and the mass of grains from a single field for both varieties were higher in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow in comparison with the other cultivation variants. Thus, after various predecessors in Barakatli 95 hard wheat variety these indicators were 275-413 pieces, 37.1-50.5 gr and 280.6-606.7 gr in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow, and in Gobustan soft wheat variety was 294-442 pieces, 34.1-48.5 gr and 298.1-625.9 gr respectively. The number of productive stems in a single field, the mass of 1000 grains and the mass of grains from a single field were obtained at most after pea predecessor in the background of $N_{60}P_{60}$ + 10 tons of manure in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow, this was 413-442 pieces, 48.5-50.5 gr and 606.7-625.9 gr respectively. In this variant, the economic efficiency coefficient was higher for both varieties. Thus, this indicator was 0.36 for Barakatli 95 variety, 0.35 for Gobustan variety.

4.7. Influence of soil cultivation and nutritional conditions on the grain productivity of wheat varieties. After wheat predecessor for both varieties the grain productivity was 15.7-17.3 cent/ha in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow in unfertilized background, 13.0-13.8 cent/ha in traditional cultivation (ploughing at a depth of 20-22 cm + harrow + disc), 14.1-15.5 cent/ha in the option of disking the soil once at a depth of 10-12 cm with a heavy-disc harrow. After pea predecessor these indicators were 17.5-19.1 cent/ha, 15.6-17.6 cent/ha and 14.3-15.1 respectively. After both predecessors the productivity in Barakatli 95 wheat variety was 13.0-17.5 cent/ha depending on cultivation in the nutritional conditions in unfertilized variant, 35.8-43.3 cent/ha in the option of $N_{60}P_{60}$ + 10 tons of manure, 33.8-41.8 cent/ha in the option of $N_{90}P_{60}K_{45}$. In Gobustan variety the productivity for these variants was 13.8-19.1 cent/ha, 38.5-45.8 cent/ha, 36.4-43.8 cent/ha respectively, the highest productivity for both varieties was observed to be in the background of $N_{60}P_{60}$ + 10 tons of manure applied after pea predecessor, and the productivity for both varieties in this background was 38.6-43.3 cent/ha and 41.1-45.8 cent/ha depending on cultivation variant (Table 4.7).

Based on the results of the three-factor analysis of the effect of the studied factors on the productivity of wheat varieties, it can be said that the effect of cultivation factors on the grain productivity of both varieties studied is significant at a probability level of 0.01. According to Duncan's criterion, it was determined that the highest productivity for both varieties was obtained in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow after pea predecessor applied in the background of $N_{60}P_{60}$ + 10 tons of manure and this was 43.3 cent/ha and 45.8 cent/ha in Barakatli 95 and Gobustan varieties respectively.

Thus, due to the studied factors, the increase in grain yield in Barakatli 95 hard and Gobustan soft wheat varieties was 78.3% and 74.5% respectively, of which 7.8% and 5.9% were predecessors, 10.9% and 10.3% fall to the share of land cultivation, 59.6% and 58.3% to the share of nutritional conditions.

Table 4.7

The effect of predecessors, soil cultivation and nutritional conditions on the grain productivity of autumn wheat varieties, cent/ha (average for 2019-2021)

Soil Culti-vation	Unfertilized		$N_{60}P_{60}$+10 tons manure		$N_{90}P_{60}K_{45}$	
	Predecessor:		Predecessor:		Predecessor:	
	Wheat	Pea	Wheat	Pea	Wheat	Pea
Barakatli 95						
T_1	13.0	14.3	35.8	38.6	33.8	36.3
T_2	15.7	17.5	39.9	43.3	37.4	41.8
T_3	14.1	15.6	37.6	40.7	35.3	38.7
Gobustan						
T_1	13.8	15.1	38.5	41.1	36.4	38.2
T_2	17.3	19.1	43.1	45.8	41.5	43.8
T_3	15.5	17.6	40.8	43.3	38.3	40.9

Note: T_1-Traditional (at a depth of 20-22 cm ploughing + disc + harrow); T_2- disking twice at a depth of 10-12 cm with a heavy-disc harrow; T_3- disking once at a depth of 10-12 cm with a heavy-disc harrow.

4.8. Influence of soil cultivation and nutritional conditions on the development of the root system in autumn wheat varieties. The amount of root mass in the 0-20 cm layer of soil in Barakatli 95 hard wheat variety was higher than in other soil cultivations in disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow after wheat predecessor which was 13.5 cent/ha. In the background of nutritional conditions in each three cultivations relatively high result was obtained in the option of $N_{60}P_{60}$ + 10 tons of manure. In this variant of cultivation, the amount of root mass changed in the range of 15.4-17.3 cent/ha. The amount of root mass in the 0-20 cm layer of soil after pea predecessor was relatively high in all variants in comparison with wheat predecessor and the highest result was observed to be 18.4 cent/ha in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow and $N_{60}P_{60}$ + 10 tons of

manure. Also the highest results was obtained in the 20-40 cm layer of soil after pea predecesor in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow and this was 6.1 cent/ha respectively. In Gobustan soft wheat variety, in both soil layers in comparison with other soil cultivations high root mass was observed to be in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow, in this layers the amount of root mass was 13.2-17.3 cent/ha and 2.4-5.7 cent/ha in traditional cultivation (at a depth of 20-22 cm ploughing + disc + harrow), 13.9-18.6 cent/ha and 2.9-6.2 cent/ha in the option of disking the soil once at a depth of 10-12 cm with a heavy-disc harrow, 14.6-19.6 cent/ha and 3.5-6.7 cent/ha in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow. In the background of nutritional conditions in each three cultivations the highest root mass was obtained in the option of $N_{60}P_{60}$ + 10 tons manure which was 16.4-19.6 cent/ha and 4.9-6.7 cent/ha. After pea predecessor in Gobustan soft wheat variety the root mass was high and for both layers these were 13.9-19.6 cent/ha and 3.3-6.7 cent/ha respectively.

According to the results of three-factor dispersion analysis of the effect of the main cultivation methods on the distribution of the root system at different depths in winter wheat varieties, the predecessor has no effect on the amount of root mass in 0-20 cm layer of soil on both varieties, the effect of soil cultivations and nutritional conditions is important at the probability level of 0.05 and 0.01. In the 20-40 cm layer of soil, the effect of all three cultivation factors is significant at a probability level of 0.01. According to Duncan's criterion, relatively the high amount of root mass for both layers was obtained in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow and $N_{60}P_{60}$ + 10 tons of manure.

4.9. Influence of soil cultivation and nutritional conditions on grain quality. In Barakatli 95 variety after wheat predecessor depending on variant while the protein, gluten and Gluten Deformation Coefficient (GDC) was 10.9-13.2%, 22.7-27.6% and 90.4-101.5 %, after pea predecessor these indicators were 11.5-14.1%, 23.5-27.9% and 88.5-98.5% respectively (Table 4.9).

Table 4.9

The effect of the main cultivation methods on the quality of wheat depending on the predecessor (average for 2019-2021)

Varieties	Soil Cultivations	Nutritional Conditions	Predecessor:					
			Wheat			Pea		
			Protein, %	Gluten, %	GDC	Protein, %	Gluten, %	GDC
Barakatli 95	T_1	C_1	10.9	22.7	101.5	11.5	23.5	98.8
		C_2	12.7	26.6	96.2	13.5	27.3	93.6
		C_3	12.3	26.3	97.5	13.1	27.0	95.4
	T_2	C_1	11.7	23.9	98.0	12.5	24.7	95.7
		C_2	132	27.6	90.4	14.1	27.9	88.5
		C_3	12.7	27.4	93.7	13.8	27.7	91.3
	T_3	C_1	11.5	23.7	99.4	12.3	23.9	96.9
		C_2	12.9	27.2	93.3	13.8	27.8	90.1
		C_3	12.5	27.0	96.5	13.3	27.6	93.6
Gobustan	T_1	C_1	10.6	24.6	104.0	11.2	25.5	100.7
		C_2	12.3	28.3	98.4	13.1	29.0	95.0
		C_3	11.9	28.0	99.9	12.7	28.7	96.9
	T_2	C_1	11.4	25.5	100.5	11.9	25.9	97.3
		C_2	12.7	29.0	93.8	13.8	29.8	90.7
		C_3	12.4	28.6	96.3	11.0	29.5	93.4
	T_3	C_1	11.1	25.3	102.3	11.7	25.8	99.0
		C_2	12.6	28.8	96.3	13.5	29.6	92.3
		C_3	12.1	28.4	99.0	13.0	29.3	95.2

Note: T_1- Traditional (at a depth of 20-22 cm ploughing + disc + harrow); T_2- disking twice at a depth of 10-12 cm with a heavy-disc harrow; T_3- disking once at a depth of 10-12 cm with a heavy-disc harrow; C_1- Unfertilized; C_2-$N_{60}P_{60}$+10 tons of manure; C_3- $N_{90}P_{60}K_{45}$.

In Gobustan soft wheat variety the amount of protein in the grain was 10.6-13.1 % on both predecessors depending on nutritional conditions in traditional cultivation, 11.4-13.8% in the option of disking twice at a depth of 10-12 cm with a heavy-disc harrow, 11.1-13.5% in the option of disking once at a depth of 10-12 with a heavy-disc harrow.

The amount of gluten and Gluten Deformation Coefficient (GDC) depending on predecessor and nutritional conditons on soil

cultivations was 24.6-29.0% and 95.0-104.0%, 25.5-29.8% and 90.7-100.5%, 25.3-29.6% and 92.3-102.3% respectively (Table 4.9).

Based on the results of dispersion analysis, it can be said that the effect of the studied factors on the protein, gluten and Gluten Deformation Coefficient (GDC) in the grain in both varieties is important at the probability level of 0.01 and 0.05. According to Dunkan's criterion, on both varieties and variants according to average value of quality indicators of grain in minimal soil cultivations the grain quality was relatively high in traditional cultivation variant (at a depth of 20-22 cm ploughing+disc+harrow). In the background of nutritional conditions it was determined to be significant differences between fertilized and unfertilized variants and in this background the relatively superior variant is $N_{60}P_{60}$ + 10 tons of manure variant.

4.10. Influence of soil cultivation and nutritional conditions on economic efficiency of autumn wheat varieties. Productivity, total cost of production, cost per hectare, net income, cost per centner and profitability of Barakatli 95 wheat variety in the background of soil cultivation and nutrition conditions from both predecessors were 13.3-43.3 cent/ha, 455.0-1515.5 azn, 262.0-553.1 azn, 193.0-962.4 azn, 12.8-20.2 azn, 73.7-174.0% respectively. In Gobustan soft wheat variety these indicators were 13.8-45.8 cent/ha, 483.0-1603.0 azn, 272.0-563.1 azn, 211.0-1039.9 azn, 12.3-19.7 azn, 77.6-184.7% respectively. Thus, in the background of predecessor, soil cultivation and nutritional conditions on both prdecessors studied in not-irrigated conditions after pea predecessor the economical and high profitable cultivation was obtained in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow that these were 174.0% and 184.7% in Gobustan soft wheat variety respectively.

The result

1. The field germination of seeds, winter resistance and the amount of plants that survived up to the harvesting period after pea predecessor was obtained in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow and of $N_{60}P_{60}$ + 10 tons of manure that these were on varieties 360-454 pieces/m^2

(88.5-90.8%), 337-439 pieces/m^2 (93.6-96.7%) and 318-424 pieces/m^2 (94.4-96.4%).

2. Under Barakatli 95 hard and Gobustan soft wheat varieties the lowest weeding was determined after pea predecessor in the option of disking the soil twice at a depth 10-12 cm with a heavy-disc harrow and the amount of weeds in a single field on both varieties on March and April was 26.1-3.9 pieces/m^2 and 18.7-3.4 pieces/m^2.
3. In not-irrigated conditions after pea predecessor the total vegetation period being long relatively in comparison with the other cultivation variants was 220-223 days respectively in the option of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow.
4. The application of proper cultivation methods is important for crop growth and the formation of structural elements. Thus, in not-irrigated conditions after pea predecessor the disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow in the background of $N_{60}P_{60}$ + 10 tons of manure had caused the improvement of the structural indicators of the product and the increasing of productivity. In this variant the productivity in Barakatli 95 variety was 43.3 cent/ha, and in Gobustan variety was 45.8 cent/ha.
5. The amount of root mass on varieties studied after pea predecessor was high in the option of $N_{60}P_{60}$ + 10 tons of manure and of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow that this also changed at a range of 6.1-19.6 cent/ha in the varieties studied on both soil layer.
6. Due to factors studied the grain product in Barakatli 95 hard and Gobustan soft wheat variety was 78.3-74.5% that of which 7.8% and 5.9 % falls to the share of predecessor, 10.9% and 10.3% to the share of soil cultivation, 59.6% and 58.3% to the share of nutritional conditions.
7. On both varieties in the optimal variant of experiment the quality indicators of grain was high in comparison with the other variants in the option of $N_{60}P_{60}$ + 10 tons of manure and of disking the soil twice at a depth of 10-12 cm with a heavy-disc harrow. In this variant in Barakatli 95 variety the amount of protein and gluten was 14.1% and 27.9%, in Gobustan variety was 13.8% and 29.8% respectively.

8. In the background of predecessor, soil cultivation and nutritional conditions after pea predecessor the economical and high profitable cultivation was obtained in the option of disking the soil twice at a depth of 10-12 cm with a heavy disc harrow that these were 174.0% and 184.7% in Gobustan soft wheat variety respectively.

Production recommendations

1. It is recommended to use peas as a valuable predecessor for autumn wheat in ensuring the efficient use of land in not-irrigated conditions, as well as in obtaining high and quality products;
2. In the dry, not-irrigated conditions minimizing soil cultivations is efficient economically. For this reason, it is advisable to cultivate the soil twice at a depth of 10-12 cm with a heavy-disc harrow for winter wheat cultivation in the dry and not-irrigated conditions of South Mugan;
3. It is advisable to provide $N_{60}P_{60}$ + 10 tons of manure per hectare to produce high-yield and high-grain-quality product in the dry, not-irrigated conditions of South Mughan.

The main provisions of the dissertation are reflected in the following published articles:

1. Feyzullayev H.M. Influence of cultivation methods in the non-irrigated conditions on the amount of plants that survived the harvest in wheat varieties //-Baku: The scientific news journal of Odlar Yurdu University, - 2021, №59, - p.99-103.
2. Feyzullayev H.M., Rzayev M.Y. The effect of predecessors, soil cultivation and nutritional conditions on field germination of autumn wheat varieties // - Ganja: Azerbaijan University of Technology Scientific News, - 2021, № 2/35, - p. 73-77.
3. Huseyn M. Feyzullayev Effect of cultivation methods on plant number of autumn wheat varieties after wintering in non-irrigated conditions of South Mugan // -Baku: Khazar Journal of Science and Technology, - 2021, vol. 5, №1, - p. 10-17.
4. Feyzullayev H.M. The effect of basic cultivation methods on the distribution of root in the soil layers in autumn wheat varieties // -

Nakhchivan: Journal of scientific news of Nakhchivan State University, - 2021, №1(112)- p.79-83.
5. Feyzullayev H.M. Influence of the main methods of the soil cultivation on the distribution of root system of autumn wheat at different depths in the non-irrigated conditions of South Mugan // News of Michurin State Agrar University, - 2021, №3 (66), - p.53-56.
6. Feyzullayev H.M. Influence of the main methods of cultivation on the weediness of the area of autumn wheat crops in the non-irrigated conditions // Agricultural Science, - 2021, №354 (11-12), - p.118-121.
7. Feyzullayev H.M. Influence of soil cultivation and nutritional conditions on the viability of autumn wheat varieties after different predecessors in dry conditions // Multidisciplinary Republican scientific-practical conference on "Heydar Aliyev's legacy in the development strategy of Azerbaijan" dedicated to the national leader H.A. Aliyev's 98th anniversary (Online), Part I, - Baku: West Caspian University, - 2021, 6-7 of May, p.143-147.
8. Feyzullayev H.M. Influence of different soil cultivations and feeding conditions on the grain quality of autumn wheat in the non-irrigated conditions // Materials of the X International Scientific Conference on "Scientific achievements and challenges in biology", - Baku: Baku State University, - 2021, 6-7 of May, p.350-353.
9. Feyzullayev H.M., Rzayev M.Y. Influence of different soil cultivations and nutrition conditions on the grain quality of autumn soft wheat variety depending on the predecessor in the non-irrigated conditions of South Mugan // International Scientific-Practical Conference "Soil-ecological problems of agrocenoses and ways to solve them", - Baku: Institute of Soil Science and Agrochemistry, - 2021, 3-4 of June, p. 35-37.
10. Feyzullayev H.M. Influence of different cultivation methods of nutrition conditions on the development of autumn wheat varieties depending on the predecessor // XIII International Scientific and Practical Conference "Global Science and Innovation 2021: Central Asia", - Nur-Sultan – 2021, 30 of June, №2(13),-p. 51-54.
11. Feyzullayev H.M. Influence of nutritional conditions and soil cul-

tivation on structural elements and grain yield of autumn wheat after various predecessors in the non-irrigated conditions of South Mugan // Materials of the international scientific-practical conference on "Modern problems of animal husbandry and innovative concepts" dedicated to the 90th anniversary of the establishment of the Animal Husbandry Research Institute and the 120th anniversary of academician F.Malikov, - Baku: Animal Husbandry Research Institute, -2021, 22-24 of December, -p. 344-347.

12. Feyzullayev H.M. Ahmedov S.G. Influence of the main cultivation methods on the structural elements of autumn wheat and grain production in short crop rotation // International scientific-practical conference “Innovative technologies - the basis for the modernization of the agro-industrial complex” 85th anniversary of Professor Krivko N.P. -Persian- 2022, 9 of February, -p.137-140.

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Address: AZ 1098; Azerbaijan Republic, Baku city, Pirshagi settlement, Sovkhoz №2, Research Institute of Crop Husbandry.

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