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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

STUDY OF THE EFFECT OF SOWING AND FERTILIZER RATES ON BARLEY YIELD AND NITROGEN UPTAKE

Specialty: 3101.01. "Agrochemistry"

Field of science: Agrarian sciences

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INTRODUCTION

Relevance of the subject: Barley (*Hordeum vulgare* L.) ranks as one of the most important places after wheat in the republic. Bythe use of mineral fertilizers, barley increases by 50% of the yield. This feature of barley gives reason to use it in research. The short growing season allows for a quick yield, which regenerates the soil and provides a basis for obtaining the second harvest. It is important in countries where animal husbandry is developed.

The main goal of research on grain crops is to increase yield, improve and increase economic efficiency, and develop the economy - to attract the farmers' interest in this area. In general, the main objectives of barley growing programs are the development of new high yielding and quality, stress-resistant varieties[1,2].

To obtain a high and high-quality yield, it is very important to carry out spring tillage. A new approach and modernization methods are needed for protection of the environment, sustainability and productivity of soil resources[3].

Barley yields have varied significantly in recent years due to climate change. The literature shows that the high yield of barley depends on the fertilizer rates and amount of precipitation[4].

The purpose and objectives. The main goal of the study is to studythe impact of sowing and fertilizerrates to the biomass yield, nitrogen content in biomass, nitrogen content in biomass in percentage, barley yield and yield quality, and nitrogen uptake. Determine the impact on the soil, and the effectiveness of mineral fertilizers,

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[1] Hajimammadov I.M. Influence of concentrated fertilizers on nitrogen metabolism and productivity of winter wheat // Moscow Publishing House: Agrochemistry. - 1975 No. 1, - Art. 12-15.

[2] Knezevic D. Variability of grain yield and quality of winter barley genotypes (*H. vulgare* L.), under the influence of nitrogen nutrition / D.Knezevic, M.Milosevic, A.Torbica [et all.] // Növénytermelés, 2011, 60, 25-28.

[3] Sainju UM. Tillage, cropping sequence, and nitrogen fertilization influence dryland soil nitrogen// Agron J, 2013, 105, -p.1253–1263.

[4] Gaevaya, E.A. Yield of spring barley depending on the weather conditions of the Rostov region // Proceedings of the Orenburg State Agrarian University. - 2017, - No. 4 (66), - C, 71–75.

and the most optimal, cost-effective sowing and fertilizer rates for cultivation in the region. Study the soil-climatic conditions of the region during the research years;

1. Determination of dynamics of easily assimilated nitrogen (N/NO_3, N/NH_3) potassium (K_2O), exchanged for phosphorus (P_2O_5) depending on the sowing and fertilizer rates.

2. Accumulationof above ground biomass and yielddepending on the rate of mineral fertilizers in different stages of plant development and determination of dependence of yieldon the nitrogen contentin above ground biomass:

3. Determination of the effect of nitrogen on the above ground biomass at different stages of the development of plants.

4. Study of the dependence of the yield on the nitrogen produced in above ground biomass and biomass yield in the milk ripe stage.

5. Determination of the effect of sowing and fertilizer rates on the key quality parameters of "Jalilabad-19" barley variety;

6. Study of the effect of sowing and fertilizer rates on winter barley yield and economic efficiency.

1. **Research methods.**The analysis of soil and plant samples in the laboratory is carried out by the following methods. (by methods).[5]

Soil analysis:

1. Calcium carbonate ($CaCO_3$) - in calcimeter by the Schebler method

2. pH-aqueous solution - in pH meters

3. Total humus - I.V. By the Tyurin method

4. Total nitrogen (N) - by the Keldal method

5. Ammonium Nitrogen - by the D.P. Konev method

6. Nitrate nitrogen - by the method of Grandvel-Lyaju

7. Active phosphorus (P_2O_5) - soluble in 1% ammonium carbonate - by the method of Machik

8. Exchangeable potassium (K_2O) - soluble in 1% ammonium carbonate [$(NH_4)_2CO_3$] - on the flame photometer.

[5] Hajimammadov IM Methods of agrochemical analysis of soil, plants and fertilizers / IM Hajimammadov, JM Talai, EM Kosayev - Baku: "Muallim", - 2016, -132 p.

Plant analysis:

2. Nitrogen-Keldal method in above ground biomass and grain

3. Statistical analysis is carried out by the SPSS26 program.

The main provisions of the defence.

1. Dynamics of easily assimilated nitrogen (N/NO_3, N/NH_3) potassium (K_2O), exchanged phosphorus (P_2O_5) depending on the rates of sowing and fertilizers in the different growth stages of "Jalilabad19".

2. Effect of sowing and fertilizers rates on the dynamics of assimilation of the above ground biomass in the different growth stages of "Jalilabad19".

3. Dependence of the amount (in percentage) and assimilation of nitrogen in above ground biomass on the sowing and fertilizer rates in the different growth stages of "Jalilabad19".

4. Yield, structure parameters and quality of barley plant in various rates of sowing and fertilizer;

5. Economic efficiency.

Scientific novelty in research: For the first time the dependence of yield and yield quality of "Jalilabad-19"barley variety on easy assimilated essential nutrient preservation in the soil during the stem elongation stage, above ground biomass yield and nitrogen percentage in above ground biomassfrom the spring tillering to the stem elongation stage, from stem elongation stage to milky stage, sowing rates in the mountain supply rainfed light gray-chestnut soils was determined.

For the first time in the rainfed conditions of Mountainous Shirvan, the dependence of the factors that determine the economical efficient yield of "Jalilabad-19"on the sowing and fertilizer rates has been studied.

The theoretical and practical significance of the research. During the years of research, the impact of sowing and fertilizer rates on the yield of the "Jalilabad-19" barley variety were studied, and the economically efficient sowing and fertilizer rates for the region were determined. This will have a significant impact on farmers' future access to cost-effective and high-quality yield in the region.

Approbation and application of the work. Results of the research presented at the Scientific Reporting Meetings of the Research Institute of Crop Husbandry (2016-2019), at the Republican scientific-practical conference "Academician Jalal Aliyev and Genetic Resources of Ecological Diversity" dedicated to the 90th anniversary of Academician Jalal AlirzaogluAliyev,the conference of young scientists and researchers on "Innovations in Biology and Agriculture, the solution of global challenges" dedicated to the 90th anniversary of Jalal AlirzaogluAliyev, at the International Youth Conference "Genetic and agronomic assessment of soils" at the Institute ofTimiryazev,dedicated to the 'Science Day' amongstudents, masters and doctoral students at the Institute of Soil Science and Agrochemistry of ANAS "Problems of the environment and strategies for its protection", dedicated to the 125th anniversary of T.S.MaltsevIII International Scientific and Practical Conference held in Kurgan State Academy of Agriculture on Modernization of "Agro-industrial complex" development and application of modern scientific and technological technologies for agriculture", in the materials of the International Scientific Conference "Agrarian Landscapes, Their Sustainability and Development Features" at the Kuban State Agrarian University named after I.T.Trublina. The results of the study were applied to farms in Gobustan region.

Name of the organization in which the dissertation work is performed. The dissertation work was performed at the Research Institute of Crop Husbandry, Agrarian and Innovation Center 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 consists of an introduction, four chapters, results, a list of 186 references, 11 figures and 99 tables. The title of the dissertation is 3 pages with 4210 characters, the introduction is 7 pages with 13244 characters, the first chapter is 14 pages with 32551 characters, the second chapter is 34 pages with 47725 characters, the third chapter is 62 pages with 117634 characters, the fourth chapter is 49 pages with 86 pages., results are 2 pages, 3657 characters, farm

recommendations are 1 page, 361 characters, list of used literature is 20 pages, 38297 characters, appendices are 6 pages, abbreviations and symbols are 1 page, 186 characters. The general text of the dissertation (excluding figures, tables, graphs, results, economic recommendations, appendices and bibliography) consists of 231922 characters. The total volume of the dissertation is 201 pages (total number of characters 345908).

MAIN CONTENT OF THE DISSERTATION

The relevance of the topics and the general characteristics of the dissertation are indicated in the **Introduction.**

Chapter I provides a review of the literature under the headings "Influence of physical and chemical properties of soil on the productivity of agricultural crops", "Biological properties of barley and its requirements for mineral fertilizer", "Absorption of nutrients from the soil by plants".

Chapter II presents the soil and climatic conditions of the studied territory, research materials and methods. The studies were conducted from 2016 to 2019 on supply rainfed gray chestnut soils of Gobustan RES in Mountainous Shirvan region. The pH content in the inferior layer (0-25 cm) varies between 8.1-8.4, 25-50 cm 8.4-8.6, 50-70 cm 8.7-8.8. That is, the inferior layer is weak alkaline, and the lower is strong alkaline. The areas are carbonate. The content of calcium carbonate in the depth of 0-25 cm is 9.86-10.56% in years of dependence on research, and in the lower layers is relatively high in dependence on depth, ie. depth 0-25 cm medium-carbonate, lower layers of high-carbonate. The experimented districts of Gobustan RES (Maraza), relate to lands of average quality. Depending on the years of research, the total humus content in the cover layer was 2.23-2.29%, and in the lower layers was decreased. The content of total nitrogen is 0.165-0.179% in the depth of 0-25 cm and is relatively decreased in the lower layers. The content of total phosphorus was 0.118-0.125% in the depth of 0-25 cm, depending on the years of research, in the lower layers observed a gradual decrease**.**

According to the results of 3-year studies conducted in Moun-

tainous Shirvanconditions, the amount of ammonium and nitrate nitrogen in the soil at a sowing rate of 140 kg/ha in unfertilized option was 14.3-10.20 mg/kg in a stem elongation stage, 12.20-8.34 mg/kg in milk and 11.77-7.94 mg/kg in the complete maturity stage.

At the sowing rate of 160 kg/ha and at different stages of plant development, the amount of N/NH_3, N/NO_3in the soil was less than at the sowing rate of 140 kg/ha.

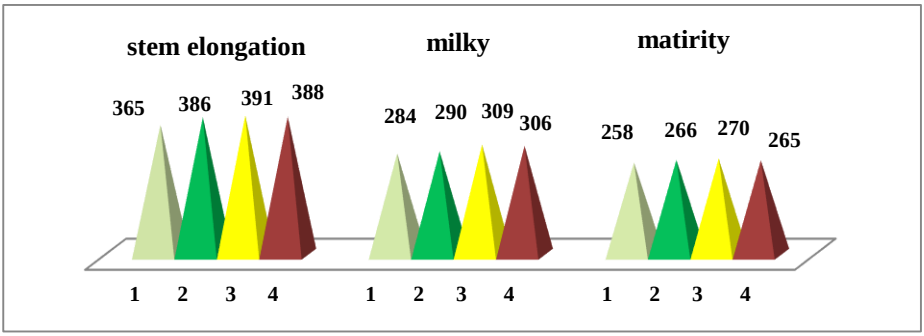
This is due to the fact that by the excessof sowing rate the yield of above ground biomass has already exceeded and the nitrogen content, uptaked by above ground biomass the content of N/NH_3, N/NO_3 in the soil was lower than in 120 kg/ha and 140 kg/ha sowing rates.

During the growth stages of the Jalilabad-19 winter barley variety, the amount of mobile phosphorus in arable soils was reduced by an average of 2,10-2,17 times for 3 years, from the control option of the stem elongation stage to end of complete maturity stage, depending on the rates of the sowing. $N_{30}P_{30}K_{30}$ fertilizer decreased by 2.38 times at the sowing rate of 120 kg/ha, at 2.42 times at the rate of 140 kg/ha, at 2.43 times at the rate of 160 kg/ha. In the norms of fertilization $N_{45}P_{45}K_{45}$ the amount of mobile phosphorus in the soil from the stem elongation stage to the complete maturity stage at the sowing rate of 120 kg/ha, 140 kg/ha and 160 kg/ha is 2.52 on average of 3 years, respectively; decreased by 2.62 and 2.57 times. According to the results of the study, the amount of mobile phosphorus in the soil from the stem elongation stage of the plant to the milk stage decreased by 1,24-1,35 times at unfertilized option depending on the sowing rate and at the complete maturity stage these indicators are decreased by 2.02-2,17 times, 2,37.-2,42 times at the $N_{30}P_{30}K_{30}$, 2,545-2,62 times at $N_{45}P_{45}K_{45}$ and 2,58-2,74 times at the $N_{60}P_{45}K_{45}$ rate of fertilization.

Disease resistance of barley plants, feeding quality of grain, resistance to lodging, productivity and economic efficiency of the variety as well as the biological characteristics of the variety depend on the degree of potassium supply of the plants during the vegetation. The results of the study showed that the dynamics (quantity) of potassium exchange (K_2O) at the stages of plant development depends

on the nutrient condition at the same sowing rate.

In the control option at a rate of 140 kg/ha in the stem elongation stage, the amount of exchangeable potassium in the soil is an average of 3 years 366 mg / kg, at the fertilizer rateof $(NPK)_{30}$ were 385 mg/kg, at the $(NPK)_{45}$ and $N_{60}(PK)_{45}$-394 mg/kg and 392 mg/kg respectively. The amount of exchangeable potassium in the soil was higher than the control of 20-26 mg/kg depending on the rate of mineral fertilizers (Fig. 2.1).



1. Control (unfertilized). 2. $N_{30}P_{30}K_{30}$. 3. $N_{45}P_{45}K_{45}$. 4. $N_{60}P_{45}K_{45}$
Figure 2.1. Dynamics of potassium exchange in the soil at a sowing rate of 140 kg/ha, depending on the fertilizer rate and ratios and growth stage of the plant

At the 140 kg/ha sowing rate, in milk stage the increase in $(NPK)_{30}$ option decreased compared to control and was 7 mg/kg. In the complete maturity stage, the amount of exchangablepotassium in the soil in the application of mineral fertilizers was 7-12 mg/kg higher than the control. The lowest increase 7 mg/kg was obtained at the fertilizer rate of $N_{60}(PK)_{45}$.

Statistical analysis of the effect of sowing and fertilizer rates on the amount of mobile phosphorus and exchangeable potassium in the soil at different stages of growth of “Jalilabad-19” barley variety was carried out (Table 2.1).

According to the dispersion analysis, the effect of fertilizer rate on the dynamics ofexchangeable potassium (K_2O) in the soil at dif-

ferent stages of plant development is significant at a probability 0.01, which indicates that changes in fertilizer rate affect the amount of potassium (K_2O) exchanged in the soil.

Table 2.1

Dispersion analysis of the effect of fertilizer rates on the dynamics of exchangeable potassium (K_2O) in the soil in the growth stages of barley

	Factors	Df	SS	MS	F
Stem elongation , %	Fertilizer rate	3	4890.89	1630.30	42.307 **
	Error	32	1233.11	38.54	
	Total	35	6124.00		
Milk stage, %	Fertilizer rate	3	3703.19	1234.40	22.449**
	Error	32	1759.56	54.99	
	Total	35	5462.75		
Complete maturity stage, %	Fertilizer rate	3	536.33	178.78	19.183**
	Error	32	298.22	9.32	
	Total	35	834.56		
**: probability 0.01					

Chapter III. Effect of sowing and fertilizer rates on growth and development of winter barley, nitrogen uptake.

The results of the research show that the above ground biomass and the percentage of nitrogen in the biomass is the main indicator of productivity formation and protein collection in the grain. From our experiments with the Jalilabad-19 winter barley variety in the light mountain gray-brown soils of Gobustan RES in 2016-2019, it became clear that the collection of above ground biomass yield in the growth stages of the plant depends on sowing and fertilizer rates, years of research. Thus, in the spring tillering of the plant, depending on the sowing rate in the unfertilized option, the yield of above ground biomass in 3 years changed on average between 11.03-12.28 cen./ha (Table 3.1).

In the application of mineral fertilizers, the amount of above ground biomass in the spring tillering of the plant differed depending on the sowing and fertilizer rates. Thus, depending on mineral fertilizers rate at the sowing rate of 120 kg/ha, the yield of above-ground dry biomass in spring is 13.57-14.90 cen./ha, while at the rate of 140

kg/ha and 160 kg/ha these indicators were 14, 81-16.04 cen./ha and 14.99-16.32 cen./ha, respectively.

Table 3.1

Amount of above ground dry biomass yield and nitrogen content in biomass in "Jalilabad-19 "winter barley variety, average for 3 years

Experiment scheme		Spring tillering		Stem elonga-tion stage		Milk stage		Complete ma-turity stage	
Sowing rate	Fertilizer rate	Above ground bio-mass, cen/ha	Nitrogen content , %	cen/ha	%	cen/ha	%	cen/ha	%
120	Control	11,03	3,03	26,68	1,29	63,15	1,04	75,10	2,42
	$N_{30}P_{30}K_{30}$	13,57	3,22	33,47	1,48	78,77	1,13	98,77	2,58
	$N_{45}P_{45}K_{45}$	14,37	3,32	36,78	1,76	86,77	1,23	108,92	2,68
	$N_{60}P_{45}K_{45}$	14,90	3,37	37,81	1,78	91,62	1,24	116,0	2,68
140	Control	12,28	2,93	30,54	1,28	72,80	0,98	83,80	2,50
	$N_{30}P_{30}K_{30}$	14,81	3,17	36,86	1,47	86,87	1,08	107,80	2,49
	$N_{45}P_{45}K_{45}$	15,41	3,31	40,95	1,74	101,77	1,20	125,72	2,61
	$N_{60}P_{45}K_{45}$	16,04	3,36	43,39	1,78	105,77	1,22	134,52	2,59
160	Control	12,23	2,94	30,17	1,28	70,42	0,96	83,68	2,41
	$N_{30}P_{30}K_{30}$	14,99	3,13	37,62	1,47	85,32	1,09	108,13	2,45
	$N_{45}P_{45}K_{45}$	15,88	3,31	42,25	1,71	102,00	1,16	126,99	2,49
	$N_{60}P_{45}K_{45}$	16,40	3,36	44,50	1,76	105,12	1,20	131,72	2,54

In the control (unfertilized) option of 120 kg/ha sowing rate in stem elongation stage the above ground biomass yield was cen./ha, and in the sowing rates of 140 kg/ha and 160 kg/ha, 30.54 cen./ha and 30.17 cen./ha, respectively. In the $N_{30}P_{30}K_{30}$ fertilizer option, the yield of the above ground biomass varied at 120 kg/ha sowing rate between 33.47 cen./ha and at 140 kg/ha and 160 kg/ha sowing rates between 30.86 cen./ha and 37.62 cen./ha, respectively. Theyield of

the above ground dry biomass was significantly higher in $N_{45}P_{45}K_{45}$ and $N_{60}P_{45}K_{45}$fertilizer rates at 140 kg/ha and 160 kg/ha sowing rates compared to 120 kg/ha sowing rate at the stem elongation stage. Thus, the yield of the above ground dry biomass was observed average 40.95 cen./ha and 43.39 cen./ha in $N_{45}P_{45}K_{45}$ and $N_{60}P_{45}K_{45}$ fertilizer rates at sowing rate of 140 kg/ha for 3 years.

In the control (unfertilized) option the yield of above ground dry biomass of plants was 63.15 cen./ha at a rate of 120 kg/ha, at the milk stage. The yield of above ground biomass at the $N_{30}P_{30}K_{30}$ fertilizer rate of 120 kg/ha sowing rates was 78.77 cen./ha and 85.32 cen./ha and 86.87 cen./ha at the 140 kg/ha and 160 kg/ha sowing rates, respectively for 3 years at the milk stage.

In the grain filling and milk stages of plants, the amount of essential nutrients in the yield of above ground biomass and biomass, including nitrogen, is a key indicator of productivity and the quality of the crop which is about 70% formed by above ground biomass and 30% by soil nutrients.

There was an impact on the rates of sowing and fertilizer on the accumulation of above ground biomass of the variety Jalilabad-19 in the grain filling stage as well as in the milk stage in the field experiments conducted in rainfed conditions of Gobustan RES.

In the field experiments carried out with “Jalilabad-19” barley variety in 2016-2019 in therainfed mountain light gray-brown soils of Mountainous Shirvan, the nitrogen content in the above ground dry biomass was 3.22-3,37% at the spring tilleringat the rate of 120 kg/ha of sowing rate. The difference compared to the unfertilized option varies from 0.21 to 0.34 or 6.93-11.22%. The difference was higher than the control for 0.24-0.43 or 8.19-14.68% at $N_{30}P_{30}K_{30}$; $N_{45}P_{45}K_{45}$ and $N_{60}P_{45}K_{45}$ fertilizers rates and the sowing rate of 140 kg/ha. Depending on the fertilizers rate and ratio at 160 kg/ha sowing rate, it did not differ from 140 kg/ha sowing rate.

Depending on the ratio of fertilizers in the stem elongation stage of the plant, the percentage of nitrogen in the above ground biomass decreases by 1.90-2.0 times, but the difference was 0.19-0.50 or 14.70-39.06% higher compared to the unfertilized option.

The nitrogen content uptake by the above ground biomass in the milk stage of the Jalilabad-19, was an average of 75-85% of the complete maturity stage.

Nitrogen accumulates predominantly in the grain, in the above ground biomass of cereals, including barley. Nitrogen in straw yield is on average 4.5-5.0 times less than nitrogen, collected in grain. The yield of straw is 1.6-2.0 times higher than that of modern short-height varieties of barley. Thus, the percentage of nitrogen in the total above ground dry biomass is slightly different from the nitrogen in the above ground biomass in the milk stage. Analogous results were obtained in our experiments with Jalilabad-19 in rainfed mountain light gray-brown soils of Mountainous Shirvan. Thus, nitrogen content in the grain was 2.14-2.37%, and in the straw was 0.31-0.45%.

The nitrogen content, uptake by above ground biomass in springtillering, varied 33.55-50.22 kg/ha at the 120 kg/ha rate of sowing,depending on the conditions of nutrition, at the rate of sowing 140 kg/ha 36.12-53, 88cen./ha and at the rate of 160 kg/ha in the range of 36.06-55.02 cen./ha for 3 years on average. The results of the study show that nitrogen content, uptake by the above ground biomass, was relatively high at a rate of 140 kg/ha and 160 kg/ha in comparison with the rate of 120 kg/ha. However, the actual difference in the rates of 140 cen./ha and 160 cen./ha was not observed.

Compared to the rate of sowing at 120 kg/ha, nitrogen content uptake by above ground biomass was 315-3.66 kg/ha and 3.20-4.85 kg/ha or higher than 7.21-7.29% and 7.37-10.17% at sowing rates of 140 kg/ha and 160 kg/ha during spring tillering of plants at different rates of nutrition, on average 3 years respectively.

In the stem elongation stage of the plant, the plant uptakes more than 60% of the nitrogen content of complete maturity. On the other hand, depending on the sowing rate the amount of nitrogen uptake in the same nutrient norm is higher than in the tillering stage. On the other hand, the nitrogen content uptake by the above ground biomass differed depending on the sowing rate in the same nutrient norm. Thus, in the control option of the sowing rate of 120 kg/ha, the

nitrogen content uptake by above ground dry biomass was 34.40 kg/ha on average in 3 years, while in the sowing rates of 140 kg / ha and 160 kg/ha this indicator was 39.09 kg/ha and 38.62 kg/ha, respectively.

By determining the nitrogen content uptake by the above ground biomass in the milk stage of cereals (wheat and barley), it is possible to give an idea about the yield of plants and the quality of the yield. The nitrogen content accumulated by above ground dry biomass of Jalilabad-19, varied in the milk stage in the range of 65.68-129.03 kg/ha, depending on the rate of sowing and nutrition (Table 3.2).

Table 3.2

Dependence of nitrogen uptake from above ground dry biomass on sowing and fertilizer rates, on average for 3 years

Sowing rate kg/ha	Fertilizer rate, kg/ha	Nitrogen uptake by total above ground dry biomass, kg/ha			
		Spring tillering	Stem elongation	Milk stage	Complete maturity stage
120	Control	33,55	34,40	65,68	181,74
	$N_{30}P_{30}K_{30}$	43,71	49,54	89,01	254,83
	$N_{45}P_{45}K_{45}$	47,69	64,73	106,73	291,91
	$N_{60}P_{45}K_{45}$	50,22	67,30	113,61	310,88
140	Control	36,12	39,09	71,34	209,50
	$N_{30}P_{30}K_{30}$	46,86	54,18	93,81	268,42
	$N_{45}P_{45}K_{45}$	51,01	71,25	122,12	328,13
	$N_{60}P_{45}K_{45}$	53,88	77,23	129,03	348,41
160	Control	36,06	38,62	67,60	201,67
	$N_{30}P_{30}K_{30}$	46,91	55,30	92,99	264,92
	$N_{45}P_{45}K_{45}$	52,54	72,24	118,32	316,21
	$N_{60}P_{45}K_{45}$	55,02	78,32	126,14	334,57

Depending on the sowing rate, the nitrogen content uptake by the above ground biomass in the unfertilized option in the milk stage was 120 kg/ha in the sowing rate, on average 65.68 kg/ha, on average in 3 years, 140 kg/ha and 160 kg/ha in the sowing rates, 71.34 kg/ha and 67.60 kg/ha respectively. As can be seen from the results, the highest increase was observed in the sowing rates of 140 kg/ha and

160 kg/ha, and compared to the sowing rate of 120 kg/ha the increase was 5.66 kg/ha or 8.61% in the sowing rate of 140 kg/ha, and 1.92 kg/ha or 2.92% at the sown rate of 160 kg/ha.

While the nitrogen content uptake by the above ground biomass, in the control option at 120 kg/ha was 181.74 kg/ha on average of 3 years in the complete maturity stage, and at the sowing rate of 140 kg/ha and 160 kg/ha this indicator was 209,50 kg / ha, respectively, and 201.67 kg/ha. The rate increase was 140 kg/ha and 160 kg/ha was 27.86-19.93 kg/ha or 15.32 10.97%, respectively.

Depending on the sowing rate in different fertilizer rates, the nitrogen content uptake bythe above ground biomass differed compared to the control (unfertilized) option. As can be seen from the results of field experiments and laboratory analyzes, depending on the rates and ratios of nutrients in the sowing rate of 120 kg/ha, the nitrogen content uptake bythe above ground biomass was between 254.83-310.88 on average in 3 years kg/ha, at 140 kg/ha and 160 kg/ha sowing rates, these indicators varied between 268.42-348.41 kg/ha and 264.92-334.57 kg/ha, respectively. The increase in the sowing rate of 140 kg/ha and 160 kg/ha compared to the sowing rate of 120 kg/ha varied between 13.59-37.53 kg/ha and 10.09-23.69 kg/ha. The results of the study showed that the difference between the sowing rates of 140 kg/ha and 160 kg/ha was within the error of the experiment. This is entirely appropriately, because one of the main limiting factors in therainfed conditions is the amount of rainfall and rainfall at stage of development of the plant, where the yield, ie the yield of above ground biomass and the nitrogencontent uptake by biomass depend on it.

Chapter IV.Effect of sowing and fertilizer rates on barley yield, quality indicators and economic efficiency.

In 2016-2019, studies of mountain light gray-brown (chestnut) soils in Mountainious-Shirvan yield of winter barley was 28.48 cen./ha at the sowing rate of 120 kg/ha and in the control (unfertilized) option for 3 years, while at the fertilizer rate $N_{30}P_{30}K_{30}$ was 38.52 cen./ha. The grain yield at the fertilization rate of $N_{45}P_{45}K_{45}$ was 42.74 cen./ha (Table 4.1).

According to the effects of sowing and fertilizer rates on the growth and development of barley plants during three research years in Mountainous Shirvanconditions, it was found that the plant height was 108.83 cm in the control (unfertilized) and 120 kg/ha sowing rate variant. The length of ear was 15.27 cm, grain weight per an ear was 1.60 g, seed number per ear 24.7, seed weight per an ear was 1.17 g, 1000 seed weight was 45.87 g. In case of increase of the sowing rate from 120 kg/ha to 140 and 160 kg/ha in the unfertilized option these indicators were observed as 104,67-113,17 cm; 16.93-17.90 cm; 1.69-1.78 g; 27,27-29,23 p; 1.40-1.34 g; 47.87-46.84 g (Fig. 4.1).

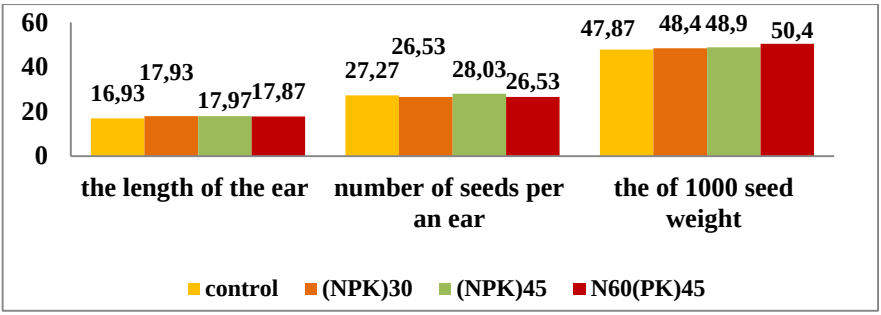


Figure 4.1. Dependence of yield structure parameters of "Jalilabad-19" barley variety on fertilizer rates at 140 kg/ha sowing rate

As can be seen, the yield of the Jalilabad-19 barley variety also changed as the sowing rate increased in the unfertilized option. Although there was an increase in the number and weight of seeds per ear, the of 1000 seed weight was the highest in the sowing rate of 140 kg/ha.

This is because as the sowing rate increased, the plant density increased and the number of seeds in the ear was high but not much. $(NPK)_{30}$ the height of the plant was 112.27 cm, 107.57 cm and 105.93 cm, the length of the ear was 17.0 cm, 17,93cm, 16.33 cm, depending on the sowing rates of 120 kg/ha, 140 kg/ha and 160 kg/ha in 30 fertilizer rates an ear weight was 1.78 g, 1.70 g and 1.65 g, number of seeds per an ear was 27.95; 26.53 and 26.04 p, the weight of seeds per an ear was 1.28 g, 1.46 g and 1.45 g according to 3-year indicators, and 1000 seed weight was 46.47 g, 48.40 g, 47.87 g depending on the sowing rates.

In $(NPK)_{45}$ nutrient mode, depending on the sowing rates of 120 kg/ha, 140 kg/ha and 160 kg/ha, the plant height was 110.33 cm, 109.73 cm and 106.23 cm, and the ear length was 16.0 cm, 17.97 cm and 17.80 cm, earweight was 1.66 g, 1.77 g and 1.85 g, the seed number per an ear was 26.0; 28.03 and 27.14 p, the seeds weight per an ear was 1.34 g, 1.54 g and 1.45 g, 1000 seed weight was 46.80 g, 48.90 g and 47.74 g.

When maintaining a constant phosphorus-potassium norm and increasing the nitrogen content norm from 45 kg/ha to 60 kg/ha, depending on sowing rate the height of the plant, reaches to 125.90 cm, 106.50 cm and 108.63 cm, the length of the ear reaches to 17.10 cm, 17, 87 cm and 17.70 cm, weight of an ear 1.76 g, 1.72 g and 1.75 g, number of seeds per ear 27.43; 26.53 and 27.97 p, seed weight per an ear 1.47 g, 1.62 g and 1.48 g, 1000 seed weight 46.74 g, 50.40 g and 47.54 g.

The effect of sowing and fertilizer rates on the quality indicators of winter barley in the rainfed mountain light gray-brown (chestnut) soils of Mountainous Shirvan was studied (Table 4.1).

Table 4.1

Effect of sowing and fertilizer rates on barley yield and quality indicators, on average in 3 years

Sowing rate kg/ha	Fertilizer rate, kg/ha	Seed yield-sen/ha	Straw yield-sen/ha	Nitrogen content in the seed, %	Raw protein content in the seed, %
120	Control	28,48	46,62	2,08	11,84
	$(NPK)_{30}$	38,52	60,08	2,17	12,35
	$(NPK)_{45}$	42,74	66,28	2,22	12,64
	$N_{60}(PK)_{45}$	44,73	71,27	2,27	12,96
140	Control	31,96	51,85	2,07	11,78
	$(NPK)_{30}$	41,37	65,08	2,13	12,14
	$(NPK)_{45}$	48,31	77,41	2,18	12,41
	$N_{60}(PK)_{45}$	51,41	83,10	2,20	12,56
160	Control	28,85	53,82	2,04	11,61
	$(NPK)_{30}$	41,03	67,10	2,14	12,51
	$(NPK)_{45}$	47,61	79,38	2,16	12,33
	$N_{60}(PK)_{45}$	48,73	83,99	2,24	12,79

From 3 years of research it was found that the nitrogen content in the seed in the control (unfertilized) option at the sowing rate of 120 kg/ha was 2.08%; The raw protein content is 11.84%, the yield of rawprotein per hectare is 337.20 kg/ha, 140 kg/ha and 160 kg/ha, these indicators are 2.07-2.04% and 11.78-11.61%, 376.49-334.95 kg/ha.

As can be seen, in the unfertilized option, no significant difference was observed between the quality indicators of the plant at different sowing rates.

In $(NPK)_{30}$ nutrient mode the nitrogen content in the seed at the rate of 120 kg/ha is 2.17%, raw protein content 12.35%, raw protein yield per hectare 475.72 kg/ha, in the sowing rates of 140 kg/ha and 160 kg/ha, these indicators were 2.13-2.14% and 12.14-12.51%, 502.23-513.28 kg/ha.

When the fertilizer rate is increased to $(NPK)_{45}$, the nitrogen content in the seed at the rate of fertilizer and sowing rate of 120 kg/ha is 2.22%, the raw protein content was 12.64%, the yield of raw protein per hectare was 540.23 kg/ha, the sowing rates of 140 kg/ha and 160 kg/ha were 2.18-2.16% and 12.41-12.33% and ranged from 599.53 to 587.03 kg/ha respectively. Similar indicators were observed when maintaining the phosphorus-potassium norm and increasing the nitrogen content from 45 kg/ha to 60 kg/ha ($N_{60}(PK)_{45}$).

Thus, in the option ($N_{60}(PK)_{45}$)at the sowing rate of 120 kg/ha according to the 3-year results, the nitrogen content in the seed is 2.27%; The raw protein content is 12.96%, while the yield of raw protein per hectare is 579.70 kg / ha, in the sowing rates of 140 and 160 kg/ha, these indicators 2.20-2.24% and 12.56-12.79%, 645,71-623.26 kg/ha was observed.

The results of the study showed that in the application of fertilizers at the rate of 120 kg/ha, the quality of the plant was higher than the rate of 140 kg/ha and 160 kg/ha. This is completely in conformity with the law, as the yield of above ground biomass at 120 kg/ha is lower than at 140 kg/ha and 160 kg/ha.

The analysis of the effect of fertilizer rates on the yield of Jalilabad-19 barley variety was analyzed and as a result it was found

that the effect of mineral fertilizers on productivity in the light gray chestnut soils of Mountainous-Shirvan is significant at the probability level of 0.01. (Table 4.2).

Table 4.2

Effect of fertilizer rates on yield of "Jalilabad-19" winter barley variety

	Factors	Df	SS	MS	F
Yield	Fertilizer rate	3	1804.35	601.45	26.097**
	Error	32	737.48	23.05	
	Total	35	2541.84		
**: the probability level of 0.01					

When calculating the economic efficiency of experiments with barley in the rainfed light gray chestnut soils of mountainous Shirvan, it was found that the total cost of sowing and fertilizer rates of 120 kg/ha was between 187.8-456.48 manat. Net income from 1 hectare area was 666.60-885.45 manat, the cost of 1 ton of product was 65.89-102.26 manat, the level of profitability due to fertilizers varied between 257.08-240.25%.

Total costs for sowing and fertilizer rates of 140 kg/ha 196.60-465.28 manat, net income from 1 hectare 762.20-1077.02 manat, cost of 1 ton of product 61.51-92.31 manat, when applying fertilizers The level of profitability was 273.36-277.20%. There was a very small difference in the level of profitability of the applied$(NPK)_{30}$ and $N_{60}(PK)_{45}$ fertilizer rates options.

Netincomefrom $N_{60}(PK)_{45}$ fertilizer rate per hectare was 1077.02 manat was higher than net income obtained in $(NPK)_{30}$ nutrient mode. As there is a very small difference between the netcost of 1 ton of product, the economic option is considered to be N_{60} $(PK)_{45}$.

Total costs for sowing and fertilizer rates of 160 kg/ha 205,40-474,08 manat, net income from 1 hectare 660,10-987,82 manat, cost of 1 ton of product 71,32-97,35 manat and level of profitability due to fertilizers was 264.32-255.83%.

Results

1. The amount of mobile phosphorus in the soil in the stages of plant emergence, milky and full maturity in "Jalilabad-19" barley variety at the same sowing rate (140 kg/ha), depending on the norm-ratio of fertilizers, on average 3 years compared to control - 5.7-11,7 mg/kg, 3.2-8.0 mg/kg and 0.2-1.3 mg/kg were high.
2. The amount of exchangable potassium (K_2O) in the soil at the same sowing rate (140 kg/ha) in the emergence, milky and complete ripening stages of "Jalilabad-19" barley variety, on average in 3 years, depending on the norm-ratio of fertilizers, - 21- 26 mg/kg, 16-25 mg/kg and 8-12 mg/kg were high.
3. In the same fertilizer rate and 140 kg/ha sowing rate above ground biomass of the plant in the spring tillering, in the milk and complete maturity stages compared to the rate of 120 kg/ha in 3 years on average were high for 1.24-1.14 cen./ha, respectively; 2.39-5.58 cen./ha; 8.11-14.15 cen./ha and 8.95-14.54 cen./ha.
4. Depending on the sowing and fertilizer rates of "Jalilabad-19" barley variety, years of research, the average nitrogen content in the total above ground biomass is 2.85-3.27% in the tillering stage, 1.33-1.68% in the stem elongation stage, milk stage 1.03-1.21% and 1.95-2.14 in the stem elongation stage compared to the spring tillering; The reasons for the 2.70-2.77 times decrease in the milk stage have been identified.
5. Nitrogen uptake of "Jalilabad-19" barley variety with above ground biomass by 46.86-53.88 kg/ha, depending on sowing rates, 140 kg/ha in spring sowing, milk and complete maturity stages; 54.18-77.23 kg/ha; 93.81-129.03 kg/ha and 268.42-348.41 kg/ha. There was no significant difference in the 160 kg/ha sowing rate compared to the 140 kg/ha, but in the 120 kg/ha sowing rate it was 3.66-37.53 kg/ha less, depending on the plant growth stages and fertilizer rates.
6. The highest grain yield in "Jalilabad-19" barley variety was at 140 kg/ha sowing, $N_{60}P_{45}K_{45}$ fertilizer rates obtained grain yield was 51.41 cen./ha on average for 3 years. This is 6.68-2.68 cen./ha

more than in the same fertilizer rate 120 kg/ha and 160 kg/ha sowing rates, respectively.

7. The highest straw yield of "Jalilabad-19" barley variety on average in 3 years was obtained by sowing rates of 140 kg/ha and 160 kg/ha and $N_{60}P_{45}K_{45}$ fertilizer rates. Straw yield was 83.10-83.90 cen./ha, respectively. This is 11.83-12.68 cen./ha higher than the sowing rate of 120 kg/ha in the same fertilizer rate.
8. Raw protein content in the seed of Jalilabad-19 barley variety varied between 12.14-12.56% at 140 kg/ha sowing rate on average in 3 years, collection of raw protein content changed between 502.23-645.71 kg/ha. The highest indicator was obtained in 140 kg/ha sowing rate at $N_{60}P_{45}K_{45}$ -645.71 kg/ha. This is higher for 144,67-22,45kg/ha compared to 120 kg/ha and 160 kg/ha sowing rates in the same fertilizer rate.
9. Net income from 140 kg/ha sowing and $N_{60}P_{45}K_{45}$ fertilizer rates is 1077.02 manat/ha, cost of 1 ton of product is 90.52 man; 120 kg/ha sowing rate compared to the same fertilizer net income is higher for 190.57 manat/ha, 1 ton of yield cost is cheaper for 11.53 manat; 160 kg/ha sowing rate compared to the same fertilizer rates is 89.20 manat/ha, the cost of 1 ton of yield was low for 6.83 manat.

Recommendations to the production

1. Along with application of 140 kg 120kg and 160 kg of sowing rates in rainfed mountain light gray-brown soils was not economically effective. Protecting land fertility is recommended to give 140 kg / ha sowing rate to obtain an economically efficient high barley yield.
2. The high and quality yield was obtained in $N_{60}P_{45}K_{45}$option when applying the $N_{30}P_{30}K_{30}$, $N_{45}P_{45}K_{45}$ and $N_{60}P_{45}K_{45}$ fertilizer rates in the rainfed conditions of Gobustan.

The main provisions of the dissertation and the obtained results are reflected in the following published scientific works

1. Hajimammadov I.M, Islamzadeh R.H Effect of sowing and fertilizer rates on yield of "Jalilabad-19" barley variety in rainfedlight-chestnut soils of Gobustan // Proceedings of RICH XXIX (2018), p.474-477.
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