REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation presented for the degree of Doctor of Philosophy (PhD)

EFFECT OF FERTILIZER RATE AND PROPORTIONS ON THE PRODUCTIVITY AND QUALITY OF POTATOES IN THE MOUNTAIN-BLACK SOILS OF GAZAKH-TOVUZ ECONOMY DISTRICT

Specialty: **3101.01 - Agrochemistry**

Field of science: **Agrarian sciences**

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BAKU- 2024

The dissertation work was performed at the "Soil-agrochemical research and mass analysis" laboratory of the AR SEM Institute of Soil Science and Agrochemistry.

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Dissertation Council FD 1.32 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at the Science and Education Ministry of the Republic of Azerbaijan, Institute of Soil Science and Agrochemistry.

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Common introduction of work

The actuality of the subject. Favorable soil and climate conditions of our republic allow to grow agricultural plants in large areas and to provide the population with agricultural products, including various types of vegetables, melons and potatoes, all year round. The issue of increasing the production of agricultural products and meeting the population's food needs currently occupies a special place in a number of state programs in the Republic of Azerbaijan.

As a continuation of the targeted policy related to the development of the regions, the "State program for socio-economic development of the regions of the Republic of Azerbaijan in 2014-2018" was approved by the decree of the country's president. Implementation of this program is considered as one of the main directions in the development of the agricultural sector, besides being of great importance in the development of the country's economy[1].

Effective using of organic and mineral fertilizers, as well as increasing the productivity of plants and meeting the population's demand for high-quality products is an actual topic today.

Agricultural production is a mechanism of continuous appropriation of natural resources, and it differs from other fields by a closer unity of society and natural factors. In fact, cultivation of agricultural crops is a more active form of human-nature interaction. The achievements of science create great material and technical changes in agriculture. In addition, in parallel, the reverse process is intensifying the pressure on natural components, including agricultural land. As a result of this pressure, there is a decrease in humus in the soil, the destruction of beneficial microflora, soil contamination with heavy metals, and the natural self-cleaning process is insufficient. Protection of the environment from direct pollution and destruction, reduction of resource-material and energy consumption of agricultural production, application of low-waste technological system and

1. "State program on reliable supply of food products to the population in the Republic of Azerbaijan in 2008-2015", Baku, 2008.

processes, minimization of the loss of agricultural products, application of nature-friendly farming system, production of ecologically pure products are highly dependent on cultivation technology.

Gadabey region has unique soil and climate conditions. Cereals, potatoes and other plants are cultivated in the mountainous soils spread in the area. Using of mineral and organic fertilizers occupies an important place among the methods that ensure high and stable yield of potatoes. From this point of view, the research works carried out in the field of determining the optimal norms and proportions of mineral and organic fertilizers are relevant.

The predmet of the research. Determination of optimal organic and mineral fertilizer norms for obtaining economically efficient and high productivity of potato plant "Sevinc" variety in mountain-black soils of Chaldash village of Gadabey region.

Research goals and objectives. The main purpose of the research is to study the effect of optimal fertilizer norms on soil fertility, productivity and quality of potatoes under the potato plant in mountain-black soils of Gadabey region, to determine the assimilation of nutrients and the economic efficiency of the fertilizers used.

The following tasks were performed to achieve the goal.

• study of soil climate conditions, agrochemical characteristics of the area to be researched;

• biological characteristics of the potato plant, the effect of fertilizers on growth of the potato plant and analysis of literature data on potato cultivation;

• determination of the dynamics of easily assimilated nitrogen (N/NO_3, N/NH_4), mobile phosphorus (P_2O_5) and exchangeable potassium (K_2O) in the soil, depending on the rates of fertilizers;

• studying the effect of organic and mineral fertilizers on potato productivity;

• study of the effect of organic and mineral fertilizers on the removal of nutrients from the soil by means of crops;

•study of the effect of organic and mineral fertilizers on quality indicators of potatoes;

•determination of the percentage of spoilage of potato tubers during storage;

• determining the effect of different norms and rates of fertilizers on the economic efficiency of the potato plant;

• determination of dispersion analysis;

Research methods. Analyzes of soil and plant samples in the laboratory were carried out by the following methods.

Soil analysis:

1. Calcium carbonate ($CaCO_3$) – in a calcimeter using the Scheybler method
2. pH-water solution - with pH meter, potensiometer
3. Common humus - By the method of I.V. Tyurin
4. Total nitrogen (N) – by the Keldal method
5. Ammonium nitrogen –By the D.P. Konev method
6. Nitrate nitrogen – by Grandwell-Lyaju method
7. Activated phosphorus (P_2O_5) - dissolved in 1% ammonium carbonate - by Machig's method
8. Exchangeable potassium (K_2O) - dissolved in 1% ammonium carbonate [$(NH_4)_2CO_3$] – in a flame photometer.
9. The statistical analysis of research results was processed in the SPSS26 program.

The main provisions of the defense:

1. The dynamics of easily assimilated nitrogen (N/NO_3, N/NH_4), exchangeable phosphorus and exchangeable potassium in different development phases of the "Sevinj" potato variety depending on fertilizer rates;
2. Dynamics of mobile phosphorus and exchangeable potassium in the soil in different development phases of "Sevinc" potato variety depending on fertilizer norms;
3. Dependence of the above-ground biomass product collection on fertilizer norms in the development phases of Sevinj" potato variety;
4. Amount of nutrient elements in above-ground biomass of fertilizer norms in the development phases of "Sevinj" potato variety;
5. Effect of organic and mineral fertilizer rates on potato productivity;

6. The amount of nutrients taken from the soil depending on the fertilizer norms in the development phases of the "Sevinj" potato variety;
7. The effect of organic and mineral fertilizers on the quality of the potato crop in mountain-black soils under the conditions of Damya;
8. Evaluation of the economic efficiency of different fertilizer rates in potato cultivation.

Scientific innovation. For the first time, the organic and mineral fertilizers applied in the mountain-black soils of Chaldash village of Gadabey region affect the height and growth of potato plants, productivity and product quality, the accumulation of nutrients in potato tubers, the assimilation of nutrients by vegetative organs of the plant and the effect on economic efficiency has been studied.

Theoretical and practical significance of research. According to the results of the research, application of organic and mineral fertilizers under the potato plant on scientific grounds has created conditions for maintaining the fertility of the mountain-black soils and increasing the productivity. Farms were offered using of N93P98K126 +Gips163 +20 tons of manure fertilizer norms for the cultivation of potatoes in mountainous soils. The proposed fertilizer rate (N93P98K126 + Gypsum 163 + 20 tons of manure) allows to achieve an efficient nutrient regime in the soil, to obtain high and quality products from cultivated plants, to maintain soil fertility and to make the cost of the product profitable.

Approbation and application of work. The results of dissertation research were published in Ganja (Ganja, 2015); in Kuban (Krasnodar, 2017); in Novosibirsk (2017); in Azerbaijan (Baku, 2018); in Ukraine (2022); It was reported at the held international conferences. 22 scientific articles, 9 thesis and conference material containing the results of the research conducted on the dissertation work were discussed.

The name of the institution where the dissertation work was performed. Dissertation work was performed at ARSEM Institute of Soil Science and Agrochemistry.

The total volume of the dissertation with characters, indicating the volume of the structural units of the dissertation separately. The dissertation consists of an introduction, five chapters, conclusions, a list of 181 literatures, 2 picture, 11 figures and 104 tables. In the structure of the dissertation, the introduction is 9 pages of 8807 marks, the first chapter is 33 pages of 62311 marks, the second chapter is 25 pages of 41771 marks, the third chapter is 56 pages of 77138 marks, the fourth chapter is 33 pages of 46854 marks, the fifth chapter is 12 pages of 21468 marks, results consists of 2 pages and 3045 marks, references to the economy are 1 page and 556 marks, the list of used literature is 18 pages and 27204 marks, appendices are 7 pages, abbreviations and conventional signs are 1 page and 138 marks. The total volume of the dissertation is 210 pages (total number of marks 239407).

Personal participation of the author. In the dissertation work, the author performed the problem setting, conducting experiment, analysis and generalization of the obtained results.

CONTENTS OF THE WORK

The relevance of the topic, the goals and tasks of the work, research methods, scientific innovation, theoretical and practical importance are shown and justified in the **introduction**.

A review of the literature on the effect of organic and mineral fertilizers on soil fertility, their role in plant life, biological characteristics and cultivation of the potato plant is given in the **first chapter**.

The procedure for calculating fertilizer rates is shown depending on the geographical position of the research area, relief, climatic features, flora, soil cover, the object of the study, methodology, agrochemical and agrophysical properties of the soil of the experimental area, and the provision of the main nutrients of the soil in easily assimilated forms in the **second chapter**.

During the years 2014-2017, the research was carried out under the Sevinj potato variety in the mountain-black soils allocated for cultivation in the Chaldash village, Gadabay district, northeastern part of the Lesser Caucasus. The main goal is to optimize fertilizer

rates, to study the effect of organic and mineral fertilizers on the productivity and quality indicators of potato plants.

Experiments were carried out with Sevinj potato variety in 6 variants, 3 repetitions. The total area of the experiment is 1100 m^2, and the area of each bed is 50 m^2. Planting scheme is 75x30. Experiments are set according to the following scheme.

1. Control (free fertilizer)
2. Organic fertilizer manure 10 t
3. Organic fertilizer manure 15 t
4. $N_{60}P_{60}K_{60}$
5. $N_{90}P_{90}K_{90}$
6. $N_{93}P_{98}K_{126}$ + $Gyps_{163}$ +20 t manure

Mineral fertilizers were used: ammonium salt as a nitrogen fertilizer (active substance 34%), double superphosphate (48%-P_2O_5) as a phosphorus fertilizer, potassium sulfate (K_2O-46%) and gypsum ($CaSO4{\cdot}2H_2O$) as a potassium fertilizer in the experiments. Gypsum was used to ensure the neutrality of the soil solution[2]. The positive effect of gypsum on the development and productivity of plants in acidic soils is related not only to the improvement of nutrition with calcium and sulfur, but also to the increase in the resistance of plants to the acidic environment as a result of the increase in calcium in the soil solution and the transition of potassium to an easily absorbed form[3].

The mechanical composition of the mountain-black soils of the research area is clay. pH content in the plow layer (0-20 cm) is 7.80, 20-40 cm -8.06, 40-60 cm -8.24, 60-80 cm - 8.28, 80-100 cm - 8.35 changes. That is, the plow layer is weakly alkaline, and the lower layers are highly alkaline. There are no carbonate compounds in the upper layers of the

[2]Korenkova D.A., "Fertilizers, their properties and methods of use" Moscow, "Kolos", 1982, p.

[3] Yagodin, B.A. Textbook for students of higher educational institutions in agronomic specialties / Edited by Academician of VASKhNIL B.A. Yagodina. - 2nd edition, revised and expanded. B.A. Yagodin - M.: Agropromizdat, 1989. - 639 p.: ill. ISBN 5-10-000624-

experimental area soils. Carbonates were completely washed away from the upper layers of the soil. However, a small amount was observed in the layers of 60-80 cm and 80-100 cm. The absence of carbonate compounds in the upper layers of the soil indicates that these soils came out from under the forest. The amount of total humus in the plow layer (0-20 cm) was 4.5%, and it decreased towards the lower layers. The amount of total nitrogen is 0.35% at the depth of 0-20 cm, and it decreases relatively in the lower layers. The amount of total phosphorus was 0.36% and total potassium was 2.62% at the depth of 0-20 cm.The fertilizer rate for the potato plant was determined according to the planned harvest, and mineral fertilizers were given to the soil with a pre-calculated rate.

Influence of fertilizer norms on the development of potato plants, the assimilation of nutrients and the dependence of the accumulation of nutrients in the above-ground part of potatoes during the growth phases of the potato are studied in the **third chapter**. From the results of the 3-year research conducted in the conditions of the soil of Chaldash village of Gadabey region, it was found that the amount of ammonium and nitrate nitrogen in the soil without fertilizer was 28.54-11.03 mg/kg in the budding phase, 25.33-8.55 mg/kg in the flowering phase, and 24.34-5.15 mg/kg was observed in the ripening phase.

Table 1.

Dynamics of active forms of nitrogen in the mountainous soils of Gadabey district, mg/kg, average over 3 years

№	Variants	Depth, cm	Budding		Flowering		Maturation	
			Absorbed N/NH_4	N/NO_3	Absorbed N/NH_4	N/NO_3	Absorbed N/NH_4	N/NO_3
1	Control (free fertilizer)	0-20	28,54	11,03	25,80	8,55	24,34	5,15
		20-40	25,41	8,07	22,55	7,28	21,30	4,46
2	Organic manure 10 t	0-20	34,11	15,81	27,86	10,03	25,26	5,56
		20-40	32,38	13,89	23,35	8,53	22,58	5,38
3	Organic manure 15 t	0-20	36,91	18,3	28,90	11,53	26,5	6,48
		20-40	35,16	16,25	25,6	10,25	23.00	5,81
4.	N60P60K60	0-20	35,8	17,66	28,16	10,78	25,74	6,31
		20-40	32,81	14,36	24,41	9,02	22,28	5,52
5	N90P90K90	0-20	37,35	18,55	28,66	11,71	27,01	6,83
		20-40	33,97	37,9	26,74	10,19	23,21	5,67
6	N93P98K126+Gyps 163+20t manure	0-20	41,02	21,06	32,79	15,17	29,03	7,98
		20-40	38,00	18,68	28,26	12,31	26,82	7,50

An increase in these indicators was observed in the version given organic fertilizer. According to the results, depending on the nutrient regime, the amount of (N/NH_4, N/NO_3) in the soil in the variant given N93P98K126+Gips163 +20 tons of manure was 41.02-21.06 mg/kg in the budding phase, and 31.06-31,03 mg/kg and 15.17-7.98 mg/kg in the flowering and ripening phases. The amount of (N/NH_4, N/NO_3) in the soil in different growth phases of the plant increased compared to the control variant.

This is due to the fact that the applied organic, mineral and ammonium nitrate and gypsum fertilizers led to the entry of nitrogen (N/NH_4, N/NO_3). Compared to the control variant, an increase in the amount of ammonium and nitrate nitrogen absorbed in the soil was observed. This increase varied depending on the growth phases of the plant. The highest indicator was observed in the budding phase of the plant. An increase in the amount of ammonium nitrogen ($N\text{-}NH_4$) and nitrate nitrogen ($N\text{-}NO_3$) was observed at the beginning of the budding phase of the potato plant, and a decrease in the flowering and ripening phase. These nutrients are mainly absorbed by plants and have a positive effect on productivity.

Table 2.

Estimating the effects of intergroup factors

Origin	Squares total SS	Df	Average square MS	F	P	Partial eta squared
Model	144,998[a]	11	13,182	4,929	0,001	69,3
Intersection	3931,018	1	3931,018	1469,965	0,000	98,4
Fertilizer rate	116,340	5	23,268	8,701	0,000	64,4
Depth	25,988	1	25,988	9,718	0,005	28,8
Fertilizer rate * Depth	2,670	5	0,534	0,200	0,959	4
Error	64,181	24	2,674			
Total	4140,198	36				
Total editing	209,180	35				
a. R Square =,693 (Corrected R squared = 0,553)						

From the P value of the fertilizer rate and depth factors in Table 2 is less than 0.01, it was determined that these factors have a significant effect on the value of N/NO_3 in the flowering phase. At the same time, it was found that the fertilizer rate had a 64.4% effect on the significant change in the amount of N/NO_3 in the flowering phase. The depth factor had a 28.8% effect on the significant change in the amount of N/NO_3 in the flowering phase. However, since the P value of the combined effects of fertilizer rate* depth factors is greater than 0.01, it is determined that these factors together have no significant effect on the value of N/NO_3 in the flowering phase.

From the research results, it was found that dynamics (amount) of mobile phosphorus (P_2O_5) and exchangeable potassium (K_2O) in the development phases of the plant was more effective in the variant where $N_{93}P_{98}K_{126}$+$Gips_{163}$+20 tons of manure was applied. Thus, in the budding phase, in the control version, the amount of activated phosphorus and exchangeable potassium in the soil was 28,01-274,64 mg/kg on average over 3 years, while it was 38,55-282,56 mg/kg in the norm of 15 t of organic fertilizer, and it was 45,35 -288,44 mg/kg and 50,30-269,23 mg/kg, respectively in $N_{60}P_{60}K_{60}$ and $N_{90}P_{90}K_{90}$ fertilizer norms. The amount of mobile phosphorus and exchangeable potassium in the soil was 27,25-28,96 mg/kg higher than the control depending on the rate of organic, mineral and ammonium nitrate and gypsum mixed fertilizers. $N_{93}P_{98}K_{126}$+Gips163+20 tons of manure in the ripening phase when organic, mineral, ammonium nitrate and gypsum mixed fertilizers were applied, the amount of active phosphorus and exchangeable potassium in the soil was 13,84-30,25 mg/kg higher than the control. Minimum growth was at the rate of 10 t organic fertilizer.

Statistical analyzes of the effect of fertilizer rates on the amount of mobile phosphorus and exchangeable potassium in the soil in different development phases of the "Sevinj" potato variety were carried out (table 3).

Table 3.

The effect of organic and mineral fertilizers on the dynamics of mobile phosphorus and exchangeable potassium under potato plants in the mountainous soils, mg/kg, average over 3 years

Variants	Depth, cm	Growth phases of plants					
		Budding		Flowering		Maturation	
		P_2O_5	K_2O	P_2O_5	K_2O	P_2O_5	K_2O
Control (free fertilizer)	0-20	28,01	274,64	24,14	270,22	20,39	266,39
	20-40	25,94	240,78	21,87	236,25	18,53	235,05
Organic manure 10 t	0-20	33,40	278,02	26,64	273,66	21,46	269,59
	20-40	31,00	244,36	24,42	239,44	19,98	235,20
Organic manure15 t	0-20	38,35	282,56	29,37	279,47	24,45	274,84
	20-40	33,88	247,57	26,88	243,14	21,87	239,46
$N_{60}P_{60}K_{60}$	0-20	45,35	288,44	34,23	285,68	27,80	280,88
	20-40	43,70	251,70	32,99	246,68	25,94	243,82
$N_{90}P_{90}K_{90}$	0-20	50,30	269,23	37,12	291,52	32,43	288,18
	20-40	48,24	255,73	34,63	251,28	27,01	248,37
$N_{93}P_{98}K_{126}$+Gyps$_{163}$+20 t manure	0-20	55,26	303,60	40,41	298,23	34,23	293,64
	20-40	52,39	261,35	37,54	257,43	32,58	253,99

It is known from the research results that different doses of mineral and organic fertilizers had an effect on the dynamics of the aerial part of the potato plant. Phenological observations were made to study the growth and development of the potato plant.

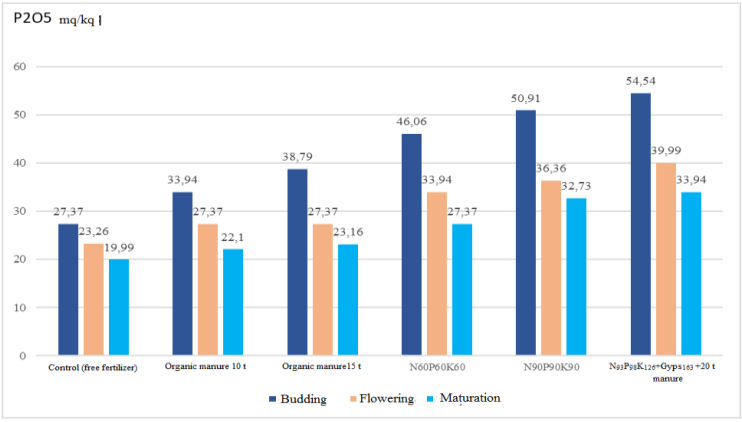

Figure 1. The effect of organic and mineral fertilizers on the dynamics of mobile phosphorus under potato plants in the mountainous soils, mg/kg, (2016)

From the experiments we conducted with the Sevinj potato variety in 2015-2017 in the Chaldash Slavyanka farm area of Gadabay region, it became clear that the height of the potato bushes, the diameter of the bushes, and the number of fruits depend on the fertilizer norms and the years of research. So, in the budding phase in 2016, the height of the plants in the control variant was 31.00 cm, the diameter of the bushes was 0.8 cm, and the number of leaves was 3. In the case of $N_{93}P_{98}K_{126}$+$Gyps_{163}$ +20 tons of manure, the height of the plants in the budding phase was 45.00, the diameter of the bushes was 2 cm, and the number of leaves increased to 13. In the application of mineral and organic fertilizers, the budding, flowering, maturation phases of the plant differed more depending on the rate of fertilizers. Precipitation within the norm affected the height of potato bushes, the diameter of the bushes and the number of fruits in 2016 year.

The amount of nutrients in the above-ground part of the plant, the productivity of the potato plant, and the amount of nutrients taken from the soil were studied in the **fourth chapter**.

From our experiments, it became clear that the accumulation of nutrients in the above-ground part of the plant during the development phases depends on the fertilizer rates. So, in different phases of the plant, in the version without fertilizer, nitrogen varied between 2.13-1.69%, active phosphorus 0.57-0.17%, exchangeable potassium 2.82-1.66% (table 4).

Table 4

The effect of mineral and organic fertilizers on the amount of nitrogen, phosphorus and potassium in the above-ground part of potatoes in mountain-black soils, %, average over 3 years

№	Variants	Budding			Flowering			Ripening		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
1	Control (free fertilizer)	2,13	0,57	2,82	1,74	0,41	2,60	1,69	0,17	1,66
2	Organic manure 10 t	2,2	0,63	2,90	1,79	0,46	2,68	1,32	0,22	1,82
5	Organic manure 15 t	2,29	0,71	3,01	1,88	0,52	2,77	1,4	0,29	1,91
6	$N_{60}P_{60}K_{60}$	2,39	0,82	3,12	1,97	0,60	2,86	1,49	0,37	1,99
7	$N_{90}P_{90}K_{90}$	2,51	0,9	3,24	2,06	0,72	3,00	1,60	0,35	2,13
8	$N_{93}P_{98}K_{126}$+$Gyps_{163}$ +20 t manure	2,73	1,08	3,42	2,62	0,9	3,22	2,38	0,67	2,33

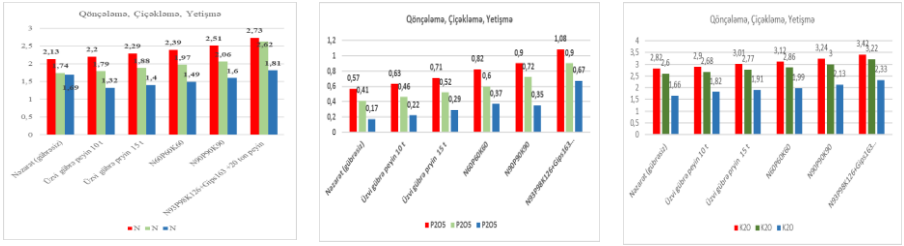

Figure 2 The effect of mineral and organic fertilizers on the amount of nitrogen, phosphorus and potassium in the above-ground part of potatoes in mountain-black soils, %, average over 3 years

The amount of nutrients in different growth phases of the plant is relatively increased on the application of organic and mineral fertilizers. Thus, when 15 t of organic fertilizer is applied, nitrogen is 2.29%, active phosphorus is 0.71%, exchangeable potassium is 3.01% in the budding phase, and in the norms of $N_{90}P_{90}K_{90}$ and $N_{93}P_{98}K_{126}$+Gyps163 +20 tons of manure, these indicators are nitrogen respectively 2,51-2,73%; activated phosphorus 0.9-1.08%; exchangeable potassium was 3.24-3.42%. In the flowering phase, nitrogen 1.74%, activated phosphorus 0.41%, exchangeable potassium 2.60% in the control (free fertilizer) variant, nitrogen was 1.88%, activated phosphorus 0.52%, exchangeable potassium 2,77% when applying 15 t of organic fertilizer. In $N_{60}P_{60}K_{60}$ and $N_{90}P_{90}K_{90}$ fertilizer variants, nitrogen varied between 1.97-2.06%, active phosphorus between 0.60-0.72%, exchangeable potassium between 2.86-3.00%. In the flowering phase of the plant, an increase in the amount of nutrients was observed compared to the standard control variant, where N93P98K126+Gips163+20 tons of manure was applied. So, the amount of nutrients in the soil was observed to be 2.62% nitrogen, 0.9% exchangeable phosphorus, and 3.22% exchangeable potassium in this variant on average over 3 years.

Nutrients in the control (without fertilizer) variant in the ripening phase are 1.69%; 0.17%; 1.66%. Nutrients increased 1.4 times compared to the control in the $N_{93}P_{98}K_{126}$+Gyps163 +20 t manure variant in the ripening phase on average over 3 years.

Based on the data obtained on average over 3 years, we can say that the amount of nitrogen, phosphorus, and potassium significantly

decreases during the flowering and ripening phases of the growing season. It is related to the formation process of the tuber.

The field experiments were conducted in the area of Chaldash village, Gadabey district, the northeastern part of the Lesser Caucasus, in the mountainous and black lands reserved for cultivation in 2015-2017. While studying the effect of fertilizer rates on potato productivity, it was found that the yield of "Sevinc" potato variety varied depending on fertilizer rates and the preparation of potato seeds for planting.

According to the results of the three-year research, the yield of the potato plant in the variants where mineral and organic fertilizers were applied in different rates and proportions was much higher than in the control (without fertilizer) option. Thus, the average yield in the version with 10 tons of manure is 175 s/ha or 16.66% compared to the control (without fertilizer) version of 10 t/ha, the productivity in the version with 15 tons of manure is 195 s/ha, 45 s/ha compared to the control option and or was 30.00%. Productivity varies depending on the norms and proportions of mineral fertilizers. Thus, in the variant given N60P60K60, the productivity was 217 s/ha, the increase compared to the control variant was 67 s/ha or 44.66%, in the variant given N90P90K90, the total yield was 245 s/ha, the increase was 95 s/ha or 63.33%. The highest productivity in the potato plant is N93P98K126+Gips163 +20 tons of manure. In this option, the average productivity increased by 266 s/ha, compared to the control option by 116 s/ha.

The main reason for the difference in productivity in the research years is the uneven amount of rains. From the results of the research, it was found that the yield obtained in 2016 was different compared to 2015-2017 in the experiments conducted with "Sevinj" potato variety in the mountainous soils of Chaldash Slavyanka farm, Gadabay district (table 5).

Table 5

Effect of different norms and proportions of mineral and organic fertilizers on the productivity of potato plants in mountain-black soils

№	Experiment variants	2015			2016			2017			Average over 3 years		
		Product cen/ha	Increase		Product cen/ha	Increase		Product cen/ha	Increase		Product cen/ha	Increase	
			cen /ha	%		cen/ ha	%		cen/ha	%		cen /ha	%
1.	Control (free fertilizer)	140	-	-	160	-	-	150	-	-	150	-	-
2.	Organic manure 10 t	165	25	17,85	190	30	18,75	170	20	13,33	175	25	16,66
3.	Organic manure 15 t	180	40	28,57	210	50	31,25	195	45	30,00	195	45	30,00
4.	N60P60K60	196	56	40,00	230	70	43,75	225	75	50,00	217	67	44,66
5.	N90P90K90	230	90	64,28	265	105	65,62	240	90	60,00	245	95	63,33
6.	N93P98K126+ Gyps163 +20 t manure	250	110	78,57	290	130	81,25	260	110	68,75	266	116	77,33
		V=1,24% P=0,72% $HCP_{0,95}$=3,51 c/ha			V=3,14% P=1,9% $HCP_{0,95}$=16,46 c/ha			V=3,01% P=1,8% $HCP_{0,95}$=14,34 c/ha			V=1,24-3,01%% P=0,72-1,9%% $HCP_{0,95}$=3,51--16,46 c/ha		

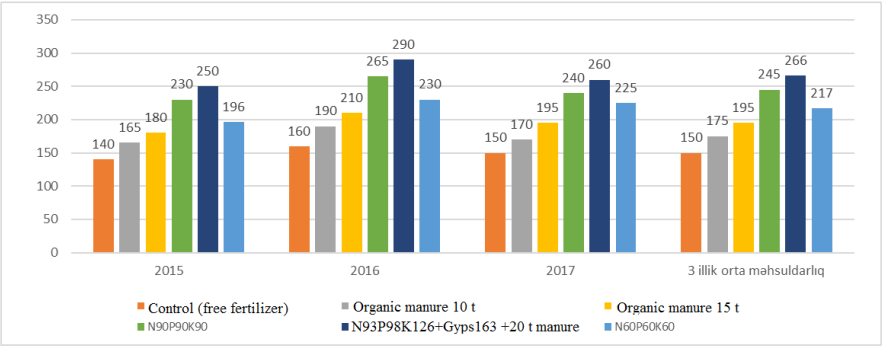

Figure 3. Effect on the productivity of the potato plant in different norms and ratios of mineral and organic fertilizers in mountain-black soils

At the same time, in the research, we studied the amount of nutrients taken from the soil by means of potato tubers of fertilizer norms. The results are given in table 6 with averages over 3 years. It

is known from the table that 24.0 kg of nitrogen, 9.0 kg of phosphorus and 84.0 kg of potassium per hectare were applied by means of 150.0 s/ha of potato tubers in the control variant without fertilizer. 33.25 kg of nitrogen, 15.75 kg of phosphorus and 105.0 kg of potassium per hectare were extracted with 175 s/ha potato crop in the 10 t option. 44.85 kg of nitrogen, 21.45 kg of phosphorus, 120.9 kg of potassium per hectare with a yield of 195 s/ha were extracted in the 15 t variant, 62.93 kg of nitrogen, 30.38 kg of phosphorus, 145.39 kg of potassium were extracted per hectare with a yield of 217.0 s/ha in the N60P60K60 variant. In the N90P90K90 variant, 83.3 kg of nitrogen, 41.65 kg of phosphorus, and 176.4 kg of potassium were absorbed per hectare with a yield of 245.0 s/ha. Nitrogen 106.4 kg, phosphorus 53.2 kg, potassium 207.48 kg per hectare were extracted out in N93P98K126+Gips163 +20 tons of manure with a yield of 265.0 s/ha.

We conducted the assimilation of nutrients varied depending on the fertilizer norms and climatic conditions in the experiments with "Sevinc" potato variety in 2015-2017 in Chaldash village of Gadabey region.

Table 6

The effect of fertilizer rates on the amount of nutrients transported from mountain-black soil by potato tubers, average over 3 years

Variants	Potato produvtivity cen/ha	Amount of nutrients %			Extraction of nutrients, kq/ha		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
Control (free fertilizer)	150	0,16	0,06	0,56	24,0	9,0	84,0
Organic manure 10 t	175	0,19	0,09	0,60	33,25	15,75	105,0
Organic manure 15 t	195	0,23	0,11	0,62	44,25	21,45	120,9
N60P60K60	217	0,29	0,14	0,67	62,93	30,38	145,4
N90P90K90	245	0,34	0,17	0,72	83,30	41,65	176,4
N93P98K126+Gyps163 +20 t manure	266	0,40	0,20	0,78	106,40	53,20	207,5

In the fifth chapter, quality indicators, spoilage percentage and economic efficiency of the potato plant were studied.

The quality indicators of potatoes in the mountainous soils of Chaldash Slavyanka farm, Gadabey district, were studied. As can be

seen from Figure 5.1, application of mineral and organic fertilizers in different rates had different effects on the accumulation of dry matter, starch, crude protein and nitrates in the potato plant.

From the 3-year research, it was found that the dry matter in the control (without fertilizer) variant is 19.65%; starch 17.23%, crude protein 2.03%, nitrate 59 mg/kg were observed. Experiments have shown that the application of mineral and organic fertilizers in different rates increased the amount of nitrates by 1.3 times compared to the control (without fertilizer) variant. Thus, while the amount of nitrates in the control (without fertilizer) variant was 59 mg/kg, it was 60.6 mg/kg in the variant with 10 t of manure, and 63.6 mg/kg in the variant with 15 t of manure. In the variant with N93P98K126+Gips163 +20 tons of manure, the amount of nitrates was determined to be 77 mg/kg.

Crude protein fluctuated between 2.18–3.32/% in variants given organic and mineral fertilizers. The best result was determined by 4.21% in the variant with N93P98K126+Gips163 +20 tons of manure.

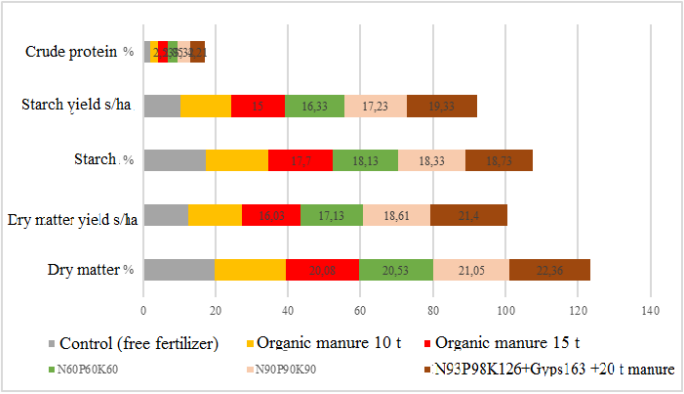

Figure 4 The effect of giving organic and mineral fertilizers in different rates and proportions on the quality indicators of the potato plant (based on 3-year average indicators)

During the research, the effect of organic, mineral and nitrate and gypsum mixed fertilizers on starch accumulation in potato plants was investigated. It was determined that in the variants given organic fertilizers, starch fluctuated between 17.43-17.7%, while in the vari-

ants given mineral fertilizers, starch was 18.13-18.33%. In the version where $N_{93}P_{98}K_{126}$+Gips163 +20 tons of manure is applied, the highest indicator is 18.73%. It has been found out from the researches that when organic fertilizer is applied to the soil, the amount of carbon dioxide released from it has increased. Carbon dioxide intensifies the process of photosynthesis in plants, which has a positive effect on the accumulation of dry matter in plants.

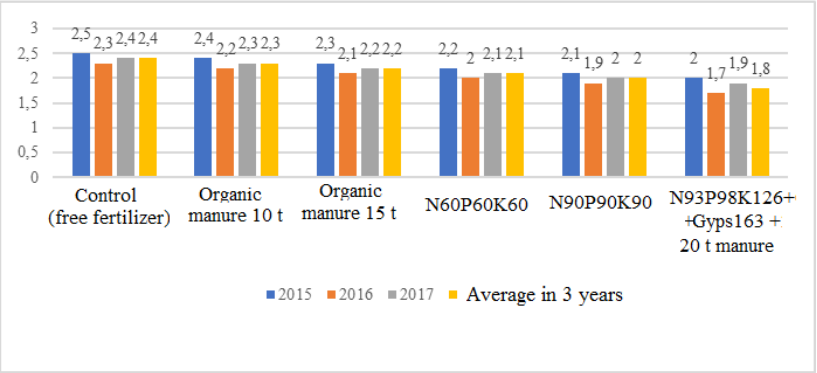

Figure 5. Effect of organic and mineral fertilizers on the percentage of spoilage of potatoes during storage (6 months) (%)

As can be seen in Figure 5, 2.4% of the crop (average over three years) in the control variant without fertilizer, 2.3% in the variant with 10 t of organic fertilizer, 2.2% in the variant with 15 t of organic fertilizer, and in the variants with mineral fertilizer It fluctuated between 2.1-2%. N93P98K126+Gips163 +20 tons of manure and in the version with compound fertilizer, 1.8% was spoiled. In this variant, the decrease in the percentage of damaged seeds depended on the applied fertilizer norms and the preparation of the seed for planting.

The economic efficiency of applying mineral and organic fertilizers under the potato plant has been studied in our research. It has been determined that the application of fertilizers under the potato plant increases productivity and its quality, as well as increases the costs of crop production.

According to the obtained net income, the economic efficiency of mixed fertilizers given $N_{93}P_{98}K_{126}$+$Gips_{163}$+20 tons of manure was better than the control variant.

As can be seen from the table, according to the 3-year experience, the highest indicator was obtained in the variant with $N_{93}P_{98}K_{126}$+$Gips_{163}$+20 tons of manure, in which the net income per hectare was 3302 manats, and the level of profitability was 98.6%.

Thus, according to our 3-year research, the best economic efficiency in mountain-black soils under the conditions of the dam is obtained in the variant of compound fertilizer $N_{93}P_{98}K_{126}$+$Gips_{163}$ +20 tons of manure.

When 10 t and 15 t of organic fertilizers were applied, the total costs were 2300-2555 manats, the value of the total product from one hectare was 4375-4875 manats, the net income from one hectare was 2075-2320 manats, the level of profitability was 90.2-90.8% .

There was little difference in the level of profitability of the variants where N60P60K60 and N90P90K90 mineral fertilizer norms were applied. In these fertilizer norms, the total costs were 2818-3150 Azn, the value of the total product from one hectare was 5425-6125 Azn, and the net income from one hectare was 2607-2975 Azn. N93P98K126+Gips163 + 20 tons of manure, the net income from 1 hectare was 3302 manats, higher than the net income from other fertilizer rates. Since there is a very small difference between the cost of 1 ton of products, the farm variant N93P98K126+Gips163 +20 tons of manure is considered.

Conclusion

1. As a result of the application of organic and mineral fertilizers in "Sevinj" potato variety in the washed mountain black soils, the amount of nutrients in the soil increased: the amount of ammonium nitrogen absorbed in the 0-20 cm layer of the soil in the budding phase compared to the control variant (28.54 mg/kg) was 5, 57-12.48 mg/kg or 19.52-43.73% increased. The increase (19.52 %) was when 10 tons of manure was applied to the soil, and the highest increase was in the

variant of mixed application (N93P98K126+Gips163 +20 tons of manure). At that fertilizer rate, the amount of nitrate nitrogen in the soil increased by 10.03 mg/kg in the budding phase. During the vegetation period, nutrients were assimilated by the plant, and during the ripening phases, the amount of absorbed ammonium decreased by 11.99 mg/kg (29.2%), and the amount of nitrate nitrogen decreased by 13.08 mg/kg (62.11%) compared to the budding phase.

2. N93P98K126+Gips163+20 tons of manure applied in "Sevinc" potato variety, the amount of mobile phosphorus in the soil during the budding, flowering, and ripening phases of the plant is respectively 27.25; 16.27; 13.84 mg/kg, on average compared to the control in 3 years; and the amount of potassium exchanged in budding, flowering, and ripening phases in that fertilizer rate is more 28.96; 28.01; 27.25 mg/kg was. Compared to the budding phase, the amount of active phosphorus decreased by 21.03 mg/kg, and the amount of exchangeable potassium decreased by 9.96 mg/kg in the ripening phase.
3. At the rate of N93P98K126+Gips163+20 tons of manure fertilizer applied to Sevinc potato variety, differences were observed in plant height, bush diameter, and number of leaves compared to the control in the budding, flowering, and ripening phases of the plant. The height of the plant in the budding phase is 14 cm, the diameter of one spike in bushes is 1.2 cm, the number of leaves is 10, in the flowering phase the height of the plant is 16 cm, the diameter of the spike is 1.2 cm, the number of leaves is 13, in the ripening phase the height of the plant is 19 cm, the diameter of the spike is 1,4 cm, the number of leaves was 17 high.
4. N93P98K126+Gips163 + 20 tons of manure fertilizer applied in "Sevinc" potato variety in the above-ground part of potatoes in 3 years on average compared to the control in budding phase nitrogen 0.6%, active phosphorus 0.51%, exchangeable potassium 0.6% respectively, nitrogen 0.88%, active phosphorus 0.49%, exchangeable potassium 0.62% in the flower-

ing phase, nitrogen 0.12%, active phosphorus 0.5%, exchangeable potassium 0.67% increased in the ripening phase. N93P98K126+Gips163 +20 tons of manure fertilizer rate nitrogen, exchangeable phosphorus, exchangeable potassium 1.04; 1,2; 1.06 times, in the flowering phase compared to budding; nitrogen, active phosphorus, exchangeable potassium 1.5; 1.6; 1.4 times in the ripening phase compared to budding; decrease was determined.

5. The highest yield was obtained at the rate of N93P98K126+Gips163+20 tons of manure fertilizer in "Sevinc" potato variety, the average yield was 266 sen/ha in 3 years. This is 43.60% higher than the control variant.
6. "Sevinj" potato tubers in the control version without fertilizer, nitrogen, phosphorus, potassium removal was 24.0 kg/ha, 9.0 kg/ha, 84.0 kg/ha. Norm of N93P98K126+Gips163+20 tons of manure increased nitrogen by 76.9%, phosphorus by 82.6%, and potassium by 58.5% compared to the control.
7. The amount of starch in the "Sevinj" potato variety was 8.00%, nitrate 23.37%, and dry matter 12.11% higher in 3 years. The highest indicator was obtained at the rate of N93P98K126+Gips163+20 tons of manure fertilizer. The applied fertilizers also affected the percentage of potato spoilage. Compared to the control, the rate of deterioration of N93P98K126+Gips163+20 tons of manure fertilizer decreased by 1.3 times in 3 years.
8. The net income from 1 hectare was 3302 manats and was higher than the net income from other fertilizer rates in N93P98K126+Gips163+20 tons of manure variant. From there is a very slight difference between the cost of 1 ton of products by variants, the farm variant is considered N93P98K126+Gips163+20 tons of manure.

FARM RECOMMENDATIONS

1. As a result of the conducted research, it is recommended to apply $N_{93}P_{98}K_{126}$+$Gyps_{163}$+20 tons of manure per hectare in

order to activate the potential fertility of the soil, increase intensive fertility, increase the productivity of potatoes, protect the environment, and obtain a quality, ecological pure potato product.

2. It is possible to obtain a yield of up to 300 s/ha if fertilizer is applied in the recommended rates ($N_{93}P_{98}K_{126}$+Gypsum 163+20 tons of manure) to the "Sevinj" potato variety in the washed mountain-black soils of Gadabey.

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9. Mahmudova E.P, Mamedbekova Z.B., Makhmudova E.P., The influence of mineral fertilizers applied on an organic background on the dynamics of nutrients in the soil. //Ecology and water management. No. 1 2022, p. 50-54
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12. Mahmudova E.P, Mammadbeyova Z.B. Mammadov Q.M., Mammadova I.Y., Mahmudova E.P., Galandarov Ch. Effectiveness of application of microbiological preparation in garden agrocenoses on irrigated grass-brown soils against the background of mineral and organic fertilizers. Actual problems of modern natural and economic sciences. International scientific conference dedicated to the 100th anniversary of the birth of national leader Heydar Aliyev. Ganja, 2023, p. 93-96
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The defense of the dissertation will be held at the meeting of the Dissertation Council FD 1.32 operating under the Institute of Soil Science and Agrochemistry of Ministry of Science and Education Republic of Azerbaijan, on "06" December at 11^{00} o'clock.

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Abstract was sent to the required addresses on
"06" November

Signed for print:
Paper format: (210x297) 1\4
Volume: 38263
Number of harrd copies: 100