

Influence of mineral and organic fertilizers on the properties of serozem-meadow soils, nutritional dynamics and productivity of amaranth

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Abstract. From the agrochemical properties of soils, their nutritional regime is of great importance. Since, plant nutrition is associated with it. In serozem-meadow soils, the nitrogen regime is in the most vulnerable position. Since the content of ammonium and nitrate nitrogen in the soil is at a minimum. The introduction of nitrogen fertilizers improving the nitrogen regime of the soil has a positive effect on the growth, development and accumulation of amaranth grain yield. The most optimal fertilizer nitrogen rate was 250 kg / ha against the background of P150K200 (1-experiment), an increase in the nitrogen fertilizer rate to 300 kg / ha against this background did not significantly increase the yield of amaranth grain. The study of the norms of mineral fertilizers without applying manure and in combination with it showed that mineral fertilizers (NPK) and manure at a dose of 30 t / ha significantly improve the poor nutritional regime of serozem-meadow soils, creating a high level of nutrition for amaranth plants. At the same time, the highest level of the nutrient regime of the soil was observed with the combined application of mineral fertilizers with manure. The highest yield was obtained on the N200P140K100 +30 t / ha option.

1 Introduction

The natural property of the serozem-meadow soils of the Samarkand oasis will not be able to provide plants with nutrients sufficiently. Since, the natural content of mobile nutrients is, in most cases, in a low degree of security [1-3]. Cultivated plants, in particular amaranth, carry out nutrients in high quantities during the growing season with the accumulation of biomass and grain harvest. According to scientists [4], in order to obtain 10 centners of amaranth grain yield, plants must take out 20.6 kg of N, 13.2 kg of P₂O₅ and 5.6 kg of K₂O from the soil. Amaranth green mass to take out even more nutrients. So, to create 100 centners of green mass, the plant takes out 25-30 kg of nitrogen, 18-22 kg of phosphorus and 75-85 kg of potassium [5-7]. The need for amaranth for nutrients varies at different stages of development [8-9]. The most critical periods in the nutrition of amaranth is the regrowth and flowering phase [8, 10], during this period amaranth very strongly absorbs nutrients from the soil and

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applied fertilizer, which requires a high concentration of nutrients in the soil. Some authors note that amaranth absorbs nutrients in large quantities throughout the growing season.

The physical condition of the soil plays an important role in the formation of mobile nutrients in the soil. In a loose state with good aeration, optimal water regimes, a favorable condition is created for the formation of mobile nutrients and their assimilation by plants [11-16].

This increases the utilization of nutrients from soil and fertilizers.

Therefore, in plant nutrition, the physical condition of the soil and its structure are of great importance. From soil with different physical properties and conditions, the plant assimilates nutrients even at the same concentration in different rates and quantities.

At the same time, amaranth is a very demanding crop for nutrients [8] and takes them out in large quantities [10, 17]. Growth, development [7, 8, 18], accumulation of fruit elements and yield [9, 10, 19- 22], product quality [18, 21- 24] depend on the nutrition of the culture.

An increase in the concentration of mobile nutrients in the soil to an optimal value is of great importance in a cardinal improvement in plant nutrition. For these purposes, in the conditions of Uzbekistan, mineral fertilizers are mainly used.

However, the nutrients of mineral fertilizers are not fully utilized by plants. The utilization rate, especially, of phosphorus and nitrogen from fertilizers is very low - 20 and 40%, respectively [25-27]. At the same time, most of the phosphates of fertilizers in the soil are converted into an indigestible form for plants [25-30]. This is especially pronounced in carbonates soils and highly acidic soils.

Whereas the nitrogen of fertilizers, not assimilated by plants, is lost from the soil due to volatilization in the form of ammonia, oxides and molecular nitrogen [25, 27] and leaching during irrigation [25, 27]. Nitrogen losses during denitrification and irrigation depend on the physical condition of the soil. With high soil hardness, disturbed structure, aeration, low humus content, the loss of soil nitrogen and fertilization increases. [11, 14, 16].

The introduction of organic fertilizers improves the physical condition, water, thermal, air properties of the soil and creates a good condition for the growth, development of plant roots, as well as in the assimilation of nutrients and water, respiration [8, 11, 19]. At the same time, organic fertilizers are the source of all nutrients and carbon dioxide, which has a positive effect on soil properties and growth, plant development [22-24]. Improvement of soil properties under the influence of organic fertilizers increases the efficiency of mineral fertilizers.

Therefore, the study of the nutrition of amaranth plants, the effect of mineral and organic fertilizers on it, as well as soil conditions is of great importance.

2 Materials and methods

To study these issues, field experiments were carried out in the gray-earth-meadow soils of the DJambay district with the amaranth culture. In the experiments, seeds of the amaranth variety Kharkovsky-1 were sown. In the first experiment, the effect of nitrogen fertilizer rates on nutrition, growth, development of yield and quality of amaranth products was studied. In the second experiment, the effect of mineral and organic fertilizers was studied. In the first experiment, against the background of phosphorus-potassium fertilizers (P₁₅₀K₂₀₀), the effect of nitrogen was studied at rates of 150, 200, 250, 300 kg/ha. In the second experiment, the effect of manure (30 t/ha) and mineral fertilizers was studied. At the same time, mineral fertilizers were studied at different rates separately and in combination with 30 t/ha of manure.

Field experiments were laid in serozem-meadow soils of the Jambay district of the Samarkand region of Uzbekistan. The area of the plots was 224 m², of which 112 m² was registered.

Agrochemical characteristics of the soil of the experimental plot, where the effect of nitrogen fertilizers rate was studied: humus content 1.32%, gross nitrogen 0.128%, gross phosphorus 0.174%, gross potassium 2.8%, ammonium and nitrate nitrogen 8.8 and 17.6 mg/kg of soil, mobile phosphorus 22.6 mg / kg of soil, exchangeable potassium 200 mg/kg of soil. In the soil of the second experiment, where the effect of mineral and organic fertilizers on soil fertility and the yield of amaranth was studied, the humus content in the arable layer was 1.12%, total nitrogen - 0.108%, total phosphorus - 0.164%, total potassium - 2.38%, ammonium nitrogen (N-NH₄) 14.5 mg / kg soil, nitrate nitrogen (N-NO₃) 17.3 mg/kg soil, mobile phosphorus - 21.4 mg/kg soil, exchangeable potassium - 220 mg/kg soil. The reaction of the medium (pH) 7.35, that is, slightly alkaline.

In the experiments, nitrogen fertilizer was introduced in the form of ammonium nitrate, phosphate fertilizer-superphosphate, potassium-potassium chloride.

3 The results and discussion

The results of the study show that when only phosphorus-potassium fertilizers are applied, the nitrogen regime of the soil almost does not change, which does not significantly affect the nitrogen nutrition of plants. Nitrogen is of great importance in these conditions. Since the nitrogen content in the soil is at a minimum, and without increasing nitrogen nutrition, it is difficult to get good growth, development and yield of amaranth. Therefore, the issues of nitrogen nutrition should be addressed first. The study of the rate of nitrogen fertilizers from 150 to 300 kg/ha in active ingredients shows that the nitrogen of fertilizers sharply increases the content of both ammonium and nitrate nitrogen in the soil. With an increase in the rate of nitrogen fertilizers in the soil, the content of mineral nitrogen increases due to both forms of nitrogen.

The effect of nitrogen fertilizers on the content of mineral ammonium and nitrate nitrogen was observed within 25-30 days after their application, then the options almost leveled out and there was no significant difference in this indicator. With the introduction of high norms of nitrogen fertilizers, the concentration of ammonium and nitrate nitrogen, that is, mineral nitrogen, in the soil increases greatly (Table 1; Table 3). This contributes to an increase in nitrogen loss due to volatilization in the form of ammonia, nitrogen oxides and molecular nitrogen, as well as leaching of nitrates and partly ammonium. Since, with a strong increase in the concentration of mineral nitrogen, the soil tends to reduce them with the help of microorganisms to a safe content. This was observed when nitrogen was applied at a rate of 300 kg / ha. On the other hand, the soil, with a low humus content, cannot absorb and retain ammonium and especially nitrate nitrogen. In serozem-meadow soils, the process of nitrification of ammonium nitrogen ends in 14 days, i.e. in two weeks, the ammonium nitrogen introduced by fertilizers is completely converted into nitrates. Nitrates are quickly washed out under irrigation conditions and volatilize during denitrification. Under irrigation conditions, nitrates are quickly washed out and volatilized during denitrification. When high rates of nitrogen fertilizers are applied, the stability of the content of ammonium and nitrate nitrogen in the soil is disturbed, that is, their content begins to decrease significantly to the concentration that the soil maintains stably for a relatively long time.

Table 1. Influence of the rate of nitrogen fertilizers on the content of ammonium nitrogen in the soil, mg/kg of soil (2017) (1-experiment)

No	Variants	N-NH ₄ content, mg / kg soil (ppm)				
		17.04	20.05	20.06	20.07	20.08
1.	Control without fertilization	10,2	12,8	13,5	12,1	12,5
2.	P ₁₅₀ K ₂₀₀ - Background	13,4	15,1	17,0	14,8	15,7

3.	Background+N ₁₅₀	13,2	24,6	21,8	28,9	20,2
4.	Background+N ₂₀₀	13,0	26,3	25,4	31,2	22,8
5.	Background+N ₂₅₀	13,4	29,0	28,7	34,1	25,5
6.	Background+N ₃₀₀	13,2	31,7	30,6	36,3	27,2

The introduction of a part of nitrogen in the form of organic fertilizers(manure) has a positive effect on the content of mineral-ammonium and nitrate nitrogen, and contributes to their high content during turning for a long time. This can be seen in the results of the second experiment, where the effect of different norms of mineral fertilizers was studied separately and in combination with 30 t/ha of manure. The introduction of only one manure without mineral fertilizers, although it increased the content of mineral nitrogen during the entire growing season of amaranth, but did not bring the concentration to the level of the variants where nitrogen fertilizers were applied. The application of full mineral fertilizers against the background of 30 t/ha of manure increased the content of mineral nitrogen for a long time to a maximum, which was not even observed when very high doses of fertilizer nitrogen were applied (Table 2; Table 4).

Table 2. The effect of mineral and organic fertilizers on the content of ammonium nitrogen in the soil, mg/kg of soil (2019) (2-experiment)

No	Variants	N-NH ₄ content, mg / kg soil (ppm)				
		5.05	5.06	5.07	5.08	1.09
1.	Control without fertilization	10,8	12,5	15,0	13,5	10,8
2.	N ₁₀₀ P ₇₀ K ₅₀	11,2	17,2	19,9	16,8	13,8
3.	N ₁₅₀ P ₁₀₅ K ₇₅	10,7	20,0	23,0	21,0	14,5
4.	N ₂₀₀ P ₁₄₀ K ₁₀₀	11,0	22,3	25,1	23,0	15,1
5.	N ₂₅₀ P ₁₇₅ K ₁₂₅	11,2	24,8	27,8	24,8	16,0
6.	N ₃₀₀ P ₂₁₀ K ₁₅₀	11,4	25,7	29,2	26,0	16,4
7.	30 t/ha manure	18,8	20,8	24,0	25,5	22,8
8.	N ₁₀₀ P ₇₀ K ₅₀ +30 t/ha manure	18,8	24,5	28,8	27,7	23,0
9.	N ₁₅₀ P ₁₀₅ K ₇₅ + t/ha manure	19,0	27,0	31,1	30,0	24,4
10.	N ₂₀₀ P ₁₄₀ K ₁₀₀ +30 t/ha manure	19,5	29,8	33,0	31,5	25,1

Consequently, the increase in the content of mineral nitrogen in serozem-meadow soils when nitrogen fertilizers are applied occurs up to a certain limit, beyond which it is impossible to increase the content of ammonium and nitrate nitrogen due to a sharp increase in the loss of these forms of nitrogen in the conditions of irrigated agriculture in Uzbekistan due to leaching and denitrification.

Table 3. Influence of the rate of nitrogen fertilizers on the content of nitrate nitrogen in the soil, mg/kg of soil (2017) (1-experiment)

No	Variants	N-NO ₃ content, mg / kg soil (ppm)				
		17.04	20.05	20.06	20.07	20.08
1.	Control without fertilization	13,5	16,8	17,5	15,5	17,3
2.	P ₁₅₀ K ₂₀₀ - Background	15,6	19,0	20,5	18,2	19,6
3.	Background +N ₁₅₀	15,8	28,5	26,7	34,6	23,8
4.	Background +N ₂₀₀	15,5	30,6	28,4	37,2	27,0
5.	Background +N ₂₅₀	15,6	33,4	31,2	39,8	30,1

6.	Background +N ₃₀₀	15,8	34,3	33,0	41,3	31,5
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Thus, in serozem-meadow soils, the best nitrogen regime is created when 250 kg/ha of nitrogen is applied against the background of phosphorus-potassium fertilizers, or mineral fertilizers in the norm N₂₀₀P₁₄₀K₁₀₀ against the background of 30 t/ha of manure.

Table 4. The effect of mineral and organic fertilizers on the content of nitrate nitrogen in the soil, mg/kg of soil (2019) (2-experiment)

No	Variants	N-NO ₃ content, mg / kg soil (ppm)				
		5.05	5.06	5.07	5.08	1.09
1.	Control without fertilization	14,8	16,7	18,3	15,7	14,5
2.	N ₁₀₀ P ₇₀ K ₅₀	15,3	21,5	23,3	19,3	15,8
3.	N ₁₅₀ P ₁₀₅ K ₇₅	14,7	23,2	26,2	22,8	17,6
4.	N ₂₀₀ P ₁₄₀ K ₁₀₀	14,7	25,6	29,8	23,9	18,2
5.	N ₂₅₀ P ₁₇₅ K ₁₂₅	15,0	28,0	33,0	26,5	20,2
6.	N ₃₀₀ P ₂₁₀ K ₁₅₀	15,3	29,2	33,7	27,2	20,9
7.	30 t / ha manure	21,4	24,8	27,7	29,3	25,5
8.	N ₁₀₀ P ₇₀ K ₅₀ +30 t / ha manure	22,3	29,8	32,6	30,7	28,1
9.	N ₁₅₀ P ₁₀₅ K ₇₅ + 30 t / ha manure	23,0	33,1	37,0	32,3	30,5
10	N ₂₀₀ P ₁₄₀ K ₁₀₀ +30 t / ha manure	23,7	35,5	38,6	34,5	32,3

The content of available phosphorus plays an important role in plant nutrition. The application of phosphorus fertilizers against the background of potassium fertilizers (1-experiment) and together with nitrogen and potassium fertilizers (1 and 2-experiments) significantly increased the content of mobile phosphorus in the soil (Table 5; Table 6). With the introduction of nitrogen fertilizers against the background of PK (1-experiment), a tendency to an increase in the content of mobile phosphorus in the soil was observed. This may be due to an increase in nitrates in the soil with the introduction of nitrogen fertilizers and a decrease in pH, which contributes to the dissolution of phosphates in the soil. This was especially noticeable when applying high doses of nitrogen fertilizer.

Table 5. Influence of the rate of nitrogen fertilizers on the content of mobile phosphorus in the soil, mg/kg of soil (2017) (1-experiment)

No	Variants	P ₂ O ₅ content, mg / kg soil (ppm)				
		17.04	20.05	20.06	20.07	20.08
1.	Control without fertilizers	20,3	22,6	24,5	26,7	23,5
2.	P ₁₅₀ K ₂₀₀ -Background	32,5	30,6	28,8	33,5	27,6
3.	Background+N ₁₅₀	34,0	32,3	30,6	34,4	29,1
4.	Background+N ₂₀₀	34,8	34,2	32,9	36,2	30,8
5.	Background+N ₂₅₀	35,7	35,0	34,2	37,8	32,5
6.	Background+N ₃₀₀	37,0	36,3	36,0	39,3	33,4

The application of mineral fertilizers, including phosphorus fertilizers against the background of 30 t/ha of manure (2-experiment), led to a significant increase in the content of mobile phosphorus in the soil. Manure had a positive effect on the effectiveness of phosphate fertilizers, which is associated with a decrease in the transition of mobile phosphorus into an indigestible form when manure is applied (Table 6). On the other hand, manure is a source of organic phosphorus, the utilization rate of which is two times higher

than phosphorus mineral fertilizers in the conditions of Uzbekistan. So, organic phosphorus of manure is more protected from the transition to indigestible phosphate than phosphorus of mineral fertilizers. In this regard, the best phosphate regime in serozem-meadow soil was observed when 30 t/ha of manure with mineral fertilizers (N₂₀₀P₁₄₀K₁₀₀) was applied.

Table 6. The effect of mineral and organic fertilizers on the content of mobile phosphorus in the soil, mg/kg of soil (2019) (2-experiment)

No	Variants	P ₂ O ₅ content, mg/kg soil (ppm)				
		5.05	5.06	5.07	5.08	1.09
1.	Control without fertilizers	15,8	18,3	20,7	18,5	15,4
2.	N ₁₀₀ P ₇₀ K ₅₀	22,6	26,3	28,1	20,7	17,3
3.	N ₁₅₀ P ₁₀₅ K ₇₅	26,2	30,0	31,8	23,6	19,2
4.	N ₂₀₀ P ₁₄₀ K ₁₀₀	30,5	34,0	36,2	27,4	20,1
5.	N ₂₅₀ P ₁₇₅ K ₁₂₅	32,3	36,8	40,0	30,0	21,3
6.	N ₃₀₀ P ₂₁₀ K ₁₅₀	33,0	37,8	40,7	30,5	21,9
7.	30 t/ha manure	28,5	31,6	34,2	28,3	25,0
8.	N ₁₀₀ P ₇₀ K ₅₀ +30 t/ha manure	31,1	35,5	38,5	32,0	26,7
9.	N ₁₅₀ P ₁₀₅ K ₇₅ +30 t/ha manure	35,3	40,2	43,2	36,0	28,6
10	N ₂₀₀ P ₁₄₀ K ₁₀₀ +30 t/ha manure	37,6	41,3	44,1	37,3	30,4

In the soils of Uzbekistan, a high content of exchangeable potassium is always observed, especially in soils with a heavy texture. Only in sandy and sandy loam soils there is a low content of exchangeable potassium. The introduction of potassium fertilizers against the background of phosphorus fertilizers (1- experiment) and together with nitrogen and phosphorus fertilizers (1 and 2-experiments) and manure (2-experiment) contributed to an increase in the content of exchangeable potassium in the soil (Table 7 and Table 8). When applying nitrogen fertilizers against the background of phosphorus-potassium fertilizers (1-experiment), there was a tendency to an increase in the content of exchangeable potassium in soils. With an increase in the rate of nitrogen fertilizers, the content of exchangeable potassium increased (1-experiment). The highest content of exchangeable potassium was in the variant where mineral fertilizers were applied at the rate of N₂₀₀P₁₄₀K₁₀₀ against the background of 30 t/ha of manure.

Table 7. Influence of the rate of nitrogen fertilizers on the content of exchangeable potassium in the soil, mg / kg of soil (2017) (1-experiment)

No	Variants	K ₂ O content, mg / kg soil (ppm)				
		17.04	20.05	20.06	20.07	20.08
1.	Control without fertilizers	180	200	210	190	210
2.	P ₁₅₀ K ₂₀₀ - Background	240	250	240	260	240
3.	Background +N ₁₅₀	250	260	240	270	250
4.	Background +N ₂₀₀	250	270	250	270	250
5.	Background +N ₂₅₀	260	270	250	280	250
6.	Background +N ₃₀₀	260	270	260	280	260

Table 8. The effect of mineral and organic fertilizers on the content of exchangeable potassium in the soil, mg/kg of soil (2019) (2-experiment)

No	Variants	K ₂ O content, mg / kg soil (ppm)				
		5.05	5.06	5.07	5.08	1.09
1.	Control without fertilizers	180	190	200	210	190

2.	N ₁₀₀ P ₇₀ K ₅₀	200	210	220	220	200
3.	N ₁₅₀ P ₁₀₅ K ₇₅	210	220	230	220	210
4.	N ₂₀₀ P ₁₄₀ K ₁₀₀	220	230	240	230	210
5.	N ₂₅₀ P ₁₇₅ K ₁₂₅	230	250	250	240	220
6.	N ₃₀₀ P ₂₁₀ K ₁₅₀	240	250	250	240	220
7.	30 t/ha manure	250	270	280	260	250
8.	N ₁₀₀ P ₇₀ K ₅₀ +30 t/ha manure	260	290	300	270	260
9.	N ₁₅₀ P ₁₀₅ K ₇₅ +30 t/ha manure	280	300	310	280	270
10	N ₂₀₀ P ₁₄₀ K ₁₀₀ +30 t/ha manure	290	300	320	280	280

Thus, the introduction of nitrogen fertilizers against the background of phosphorus-potassium fertilizers of a complete set of mineral fertilizers separately and together with 30 t/ha of manure will significantly improve the nutritional regime of gray-earth-meadow soils in the DJambay district of the Samarkand region of Uzbekistan, which creates a good background for the nutrition of amaranth plants.

This is confirmed in the growth and development of amaranth plants. Since, good growth and development of plants is formed with adequate nutrition of plants [21, 22]. In the control variant without fertilization, the plants grew very slowly and, therefore, their low growth was noted in the timing of plant height registration. The use of phosphorus-potassium fertilizers without nitrogen did not increase plant growth so much. This shows that the enhancement of nitrogen nutrition is of great importance in the formation of plant growth and development (Table 9). With an increase in the rate of nitrogen fertilizers, the growth of the plant increases, the number of leaves on one plant. The highest biometric indicators were at the application of nitrogen fertilizer at the rate of 250 and 300 kg/ha against the background of PK. In the second experiment, when using mineral fertilizers at the rate of N₂₀₀P₁₄₀K₁₀₀ against a background of 30 t/ha of manure (Table 10). The introduction of some of the nutrients in the form of manure had a positive effect on the growth and development of amaranth compared to their use only in the form of mineral fertilizers. This is due to the fact that mineral forms of nutrients quickly become insoluble or are lost as a result of leaching or volatilization. Phosphorus, which passes into an insoluble form, is very difficult to turn back into an assimilable form. Only potassium of mineral fertilizers remains in a mobile form for a relatively long time, and does not significantly transform into a stationary form. At the same time, potassium is adsorbed in the soil-absorbing complex, which contributes to its preservation in the soil and prevents its leaching. The nutrients that are in the manure are stored for a long time, since they are not immediately washed out in the manure, do not volatilize and do not turn into an insoluble form as a result of some kind of reaction. On the contrary, manure is gradually mineralized over time, releasing nutrients in free form. This contributes to the gradual replenishment of nutrients lost and used by plants over a long time, which maintains a high level of nutrients in the soil. Under such conditions, a high level of plant nutrition for a long time without sharp fluctuations and stresses, which is observed when using only mineral fertilizers, especially nitrogen fertilizers.

Table 9. Influence of the rate of nitrogen fertilizers on the growth and formation of leaves of amaranth plants (2017)

No	Variants	Plant height, cm			Number of leaves, pieces / plant		
		21.05	21.06	21.07	21.05	21.06	21.07

1.	Control without fertilization	45	98	128	7	11	18
2.	P ₁₅₀ K ₂₀₀ -Background	60	127	175	15	19	28
3.	Background+N ₁₅₀	88	150	212	18	25	35
4.	Background+N ₂₀₀	112	178	228	22	27	41
5.	Background+N ₂₅₀	130	193	251	23	30	45
6.	Background+N ₃₀₀	137	201	270	25	32	50

Table 10. The effect of mineral and organic fertilizers on the growth and formation of leaves of amaranth plants (2019)

No	Variants	Plant height, cm			Number of leaves, pieces / plant		
		15.05	15.06	15.07	15.05	15.06	15.07
1.	Control without fertilization	39	89	118	5	9	16
2.	N ₁₀₀ P ₇₀ K ₅₀	74	128	187	12	18	29
3.	N ₁₅₀ P ₁₀₅ K ₇₅	81	142	207	16	23	36
4.	N ₂₀₀ P ₁₄₀ K ₁₀₀	105	163	227	20	25	39
5.	N ₂₅₀ P ₁₇₅ K ₁₂₅	118	180	237	24	31	43
6.	N ₃₀₀ P ₂₁₀ K ₁₅₀	122	185	241	26	32	45
7.	30 t/ha manure	80	138	201	14	20	32
8.	N ₁₀₀ P ₇₀ K ₅₀ +30 t/ha manure	112	170	221	21	28	40
9.	N ₁₅₀ P ₁₀₅ K ₇₅ +30 t/ha manure	123	186	243	26	33	47
10.	N ₂₀₀ P ₁₄₀ K ₁₀₀ +30 t/ha manure	127	197	256	28	36	51

Thus, the introduction of mineral and organic fertilizers, creating a high level of the nutrient regime of the soil, improves the nutrition and biometric parameters of amaranth plants. This creates the preconditions for a high yield accumulation.

With the introduction of mineral and organic fertilizers, the yield of grain and amaranth biomass significantly increased. Nitrogen fertilization significantly increased the yield and biomass of amaranth. With an increase in the rate of nitrogen fertilizers from 150 kg/ha to 300 kg/ha, the yield of amaranth increased. But with an increase in the dose of nitrogen in fertilizers from 250 kg/ha to 300 kg/ha, a significant increase in grain yield and amaranth biomass was not observed. This is due to the fact that an increase in the nitrogen norm of fertilizers from 250 to 300 kg / ha did not significantly increase the content of mineral nitrogen in the soil. Since, with an increase in the dose of nitrogen fertilizers to 300 kg / ha, the loss of mineral nitrogen from the soil increased. This contributed to the equalization of the level of nitrogen supply in these two variants (250 and 300 kg/ha N). In the second experiment, where the effect of mineral and organic fertilizers was studied separately and in combination, the highest yield was obtained with the combined application of organic and mineral fertilizers. So, on the option N₂₀₀P₁₄₀K₁₀₀ +30 t/ha of manure, the highest yield was obtained. So, in the control without fertilization, the average yield of amaranth grain for three years was 9.17 c / ha, against the background (P₁₅₀K₂₀₀) 13.43 c/ha, and with the application of nitrogen fertilizers at rates from 150 to 300 kg / ha per background P₁₅₀K₂₀₀ - from 24.32

c/ha to 36.21 c/ha. At the same time, on the $N_{150}P_{150}K_{200}$ variant, the grain yield was 24.32 c/ha, on the $N_{200}P_{150}K_{200}$ variant - 28.32 c/ha, $N_{250}P_{150}K_{200}$ - 34.70 c / ha, on the $N_{300}P_{150}K_{200}$ variant - 36.21 c / ha (Pic 1).

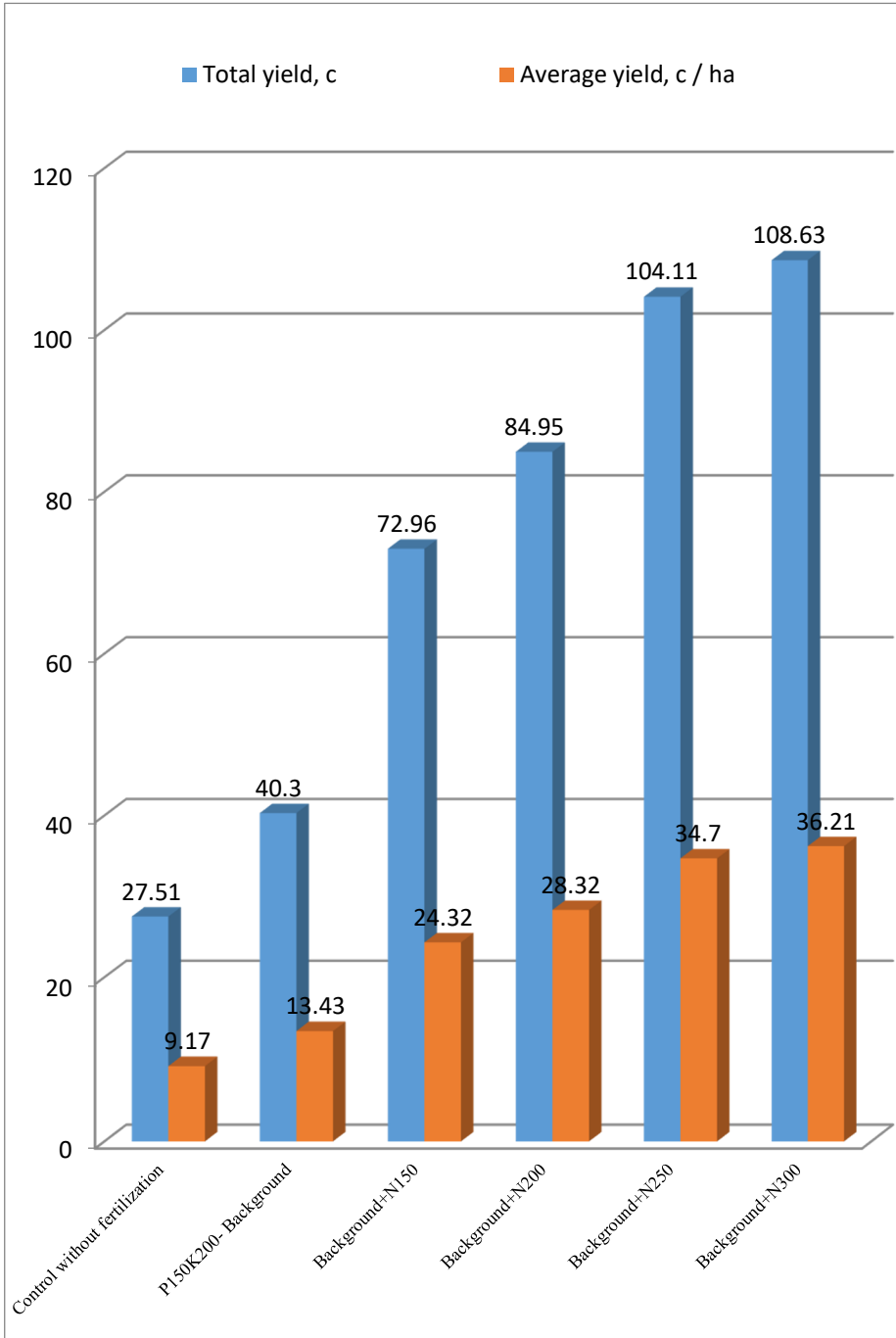


Fig. 1. Influence of the rate of nitrogen fertilizers on the yield of amaranth (average for 2015-2017)

In the second experiment, where mineral and organic fertilizers were studied separately and in combination, the average yield of amaranth grain in the control without fertilizers for three years was 17.72 c/ha. With the introduction of manure and mineral fertilizers, the yield of amaranth grain increased significantly. So, the grain yield of amaranth in the variant where only manure was applied at a rate of 30 t/ha was 31.73 c/ha, and in the variants where only mineral fertilizers were applied - from 26.59 c / ha to 37.86 c/ha (Pic 2.). At the same time, with an increase in the rate of mineral fertilizers, the yield of amaranth grain increased. So, if on variants $N_{100}P_{70}K_{50}$, $N_{150}P_{105}K_{75}$ the yield of amaranth grain was 26.59 c/ha, 30.79 c/ha, respectively, then on variants $N_{200}P_{140}K_{100}$, $N_{250}P_{175}K_{125}$, $N_{300}P_{210}K_{150}$ - 32.79, 35.89, 37.86 c/ha respectively. The application of mineral fertilizers at the rates of $N_{100}P_{70}K_{50}$, $N_{150}P_{105}K_{75}$, $N_{200}P_{140}K_{100}$ against the background of 30 t/ha of manure sharply increased the yield of amaranth grain to 34.28, 36.21, 38.37 c/ha, respectively (Table 12). Consequently, amaranth responds very strongly to the introduction of manure, as well as to the improvement of the agrochemical and agrophysical properties of the soil. This is due to the agrochemical and agrophysical properties of manure. The composition of manure feed nitrogen, phosphorus and potassium contains all other macro and microelements necessary for plants. This is of great importance in plant nutrition, since adequate nutrition leads to better growth, development and accumulation of the crop. In addition, manure, increasing organic matter in the soil, significantly improves the agrophysical properties of the soil and the conditions for the growth and nutrition of amaranth plants.

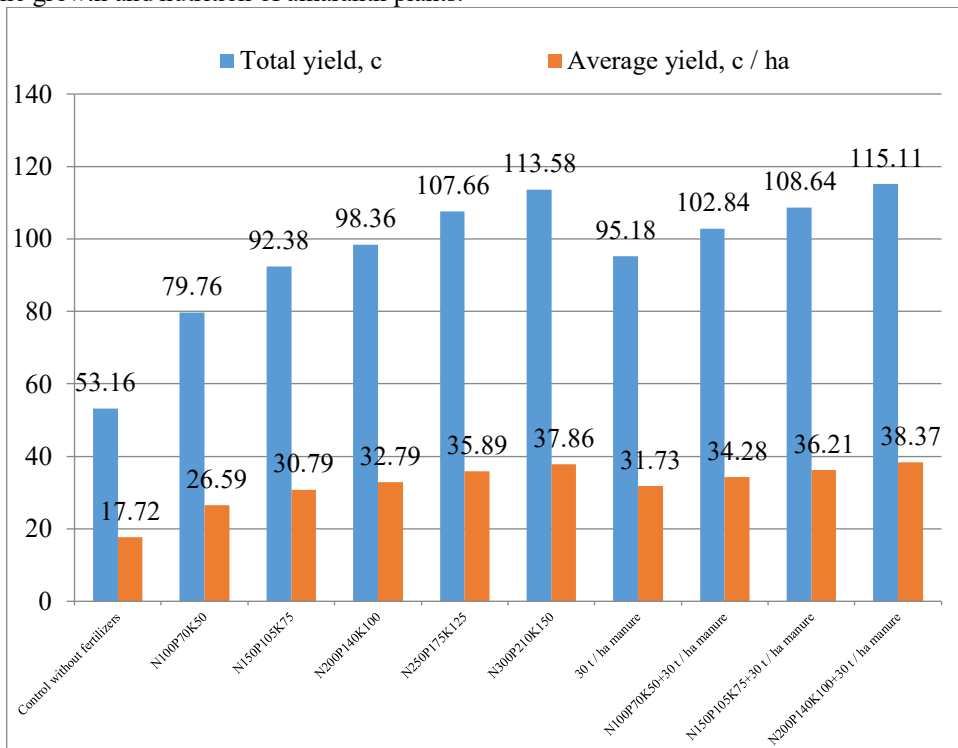


Fig. 2. The effect of mineral and organic fertilizers on the yield of amaranth (average for 2017-2019)

This is especially important in soils where the humus content is low and the physical properties are poor. Therefore, the introduction of manure against the background of mineral fertilizers has a positive effect on plant nutrition and, consequently, on their biometric

indicators. Therefore, on the options where mineral fertilizers were applied together with 30 t / ha manure, the amaranth grain yield was the highest.

4 Conclusions

Thus, mineral and organic fertilizers significantly improve the agrochemical properties of serozem-meadow soils, which optimizes plant nutrition and has a positive effect on the growth, development and accumulation of amaranth grain yield.

The introduction of part of the nutrients in the form of manure increases the efficiency of the applied mineral fertilizers, which is expressed in an increase in the coefficient of utilization of nutrients from fertilizers. This is due to the creation of good conditions for the preservation and assimilation of nutrients in mineral fertilizers. Amaranth plants respond strongly to the concentration of mobile nutrients in the soil and, therefore, to fertilization in mineral and organic forms.

At the same time, plant growth and the number of leaves increase significantly, which creates a good condition for the accumulation of biomass and the yield of amaranth grain.

Of the mineral fertilizers, nitrogen fertilization is of the greatest importance. Amaranth responds very well to nitrogen fertilization and the concentration of mineral nitrogen in the soil. Amaranth on serozem-meadow soils of Uzbekistan responds very well to the application of nitrogen fertilizers and the concentration of mineral nitrogen in the soil. The introduction of nitrogen fertilizers significantly improves the nitrogen nutrition of plants and the yield of amaranth. The amaranth plant is very demanding on nitrogen nutrition.

In the first experiment, where the rates of nitrogen fertilizers were studied against the background of P₁₅₀K₂₀₀, the application of 250 kg / ha of nitrogen turned out to be the optimal rate. In the second experiment, where different rates of complete mineral fertilizers were studied separately and in combination with 30 t/ha manure, the highest grain yield was obtained with the variants N₂₀₀P₁₄₀K₁₀₀ + 30 t/ha manure

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