

**AGROTECHNOLOGICAL BASIS FOR CULTIVATING THE ‘BAGRYANY’
CULTIVAR OF AMARANTHUS CAUDATUS L. UNDER IRRIGATED SOIL
CONDITIONS OF BUKHARA REGION**

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Abstract

This article presents the agrotechnological basis for cultivating the ‘Bagryany’ cultivar of *Amaranthus caudatus* L. under the irrigated soil and climatic conditions of Bukhara Region. During the field experiments, the effects of sowing dates and mineral fertilizer rates on plant phenological development, biometric parameters, green biomass yield, and grain yield were evaluated. The study employed methods of phenological observation, biometric measurement, yield assessment, and economic analysis.

The results showed that this cultivar is well adapted to the conditions of the Bukhara oasis and has a high capacity for biomass accumulation. Among the studied sowing dates, March 30 was identified as the most optimal in terms of phenological development and yield indicators. The application of mineral fertilizers significantly increased plant height, number of leaves, individual plant weight, and yield. The biological maximum was recorded under the N120P90K60 treatment, whereas the highest economic efficiency was observed at the N90P60K45 fertilizer rate.

The findings are of practical importance for the efficient cultivation of amaranth for fodder and grain purposes, rational resource use, yield improvement, and the development of scientifically based recommendations for farms. The obtained data also scientifically justify the possibility of introducing amaranth as an alternative crop on irrigated lands.

Keywords: Amaranth, *Amaranthus caudatus* L., ‘Bagryany’ cultivar, Bukhara Region, irrigated soils, sowing dates, mineral nutrition, agrotechnology, phenological development, biometric parameters, green biomass yield, grain yield.

Introduction

Under modern agricultural conditions, the efficient use of irrigated lands, shortage of water resources, and intensification of soil salinization processes require the introduction of alternative, highly productive, and ecologically adapted crops into agricultural production. In this regard, *Amaranthus caudatus* L. is considered one of the promising crops used for food, fodder, and partially technical purposes.

The high growth energy of this crop, intensive accumulation of vegetative biomass, high nutritional value of its grain, adaptability to hot and arid conditions, and its belonging to the C4 type of photosynthesis characterize amaranth as a biologically valuable crop for cultivation under sharply continental climatic conditions [1, 6].

The irrigated soil and climatic conditions of Bukhara Region are characterized by high temperatures, low precipitation, intensive evaporation, and a tendency toward soil salinization. Under such conditions, it becomes necessary to scientifically study the biological characteristics of crops, their agrotechnical requirements, and the factors influencing productivity formation.

The present study comprehensively analyzes the main agrotechnical factors of amaranth cultivation, including sowing dates, mineral fertilizer rates, biomass accumulation, yield, and indicators of economic efficiency. The results have important theoretical and practical significance for developing scientifically grounded recommendations adapted to regional conditions, as well as for introducing amaranth into production as an alternative agricultural crop.

Literature Review and Methodology

The nutritional value of amaranth is primarily determined by the high content and quality of protein in its grain. Modern scientific reviews indicate that the protein content in amaranth grain usually ranges from 13% to 19%, while its protein composition contains a relatively high amount of lysine, which is generally considered a limiting amino acid in cereal crops [4, 5]. In addition, amaranth is a gluten-free pseudocereal crop, making it an important food source for consumers sensitive to gluten [4]. In the food industry, amaranth is used to produce groats, flour, bakery products, biscuits, extruded products, baby food, dietary mixtures, and components of functional nutrition [4, 5].

The studies conducted by T.K. Ortikov, B.K. Shoniyozov, Kh. Sultanbekova, and A. Solobitdinova examined the influence of soil nutrients on the growth and yield of amaranth under meadow-sierozem soil conditions. It was established that soils rich in humus, nitrogen, phosphorus, and potassium are favorable for this crop, while soil fertility is one of the main factors contributing to increased yield [2].

In the studies of H. Akamine and co-authors, devoted to amaranth cultivation on different soil types, it was found that balanced NPK nutrition is one of the most effective factors increasing crop growth indicators and yield. In particular, the combined application of NPK significantly increased plant height, number of leaves, biomass, and yield, whereas unilateral nitrogen application did not produce equally high effects under all conditions. It was also noted that soil type has a substantial influence on fertilizer efficiency. These findings confirm that the

proper selection of the nutrition background is an important factor in forming high amaranth productivity [3].

Research Methods

The study used methods of field experimentation, phenological observation, biometric measurement, yield accounting, comparative analysis, economic assessment, and mathematical-statistical data processing. The experimental results were processed using analysis of variance according to the methodology of B.A. Dospekhov.

The following indicators were determined and analyzed: plant height, number of leaves, individual plant weight, leaf weight, green biomass yield, grain yield, gross income, net profit, and profitability level [7].

Results and Discussion

The study was aimed at improving the cultivation technology of *Amaranthus caudatus* L. under irrigated land conditions of Bukhara Region for fodder, green biomass, and grain production. The developed scientific recommendations are of practical importance for farms and household farms in determining optimal sowing dates and fertilizer rates, increasing yield, reducing production costs, and improving economic efficiency.

In the experiment studying mineral fertilizer rates, the unfertilized treatment was used as the control. In the other treatments, the fertilizer rates $N_{60}P_{45}K_{30}$, $N_{90}P_{60}K_{45}$, and $N_{120}P_{90}K_{60}$ were applied. The main objective of this experiment was to determine the effect of mineral nutrition levels on vegetative growth, leafiness, individual plant weight, leaf weight, and total green biomass yield of the 'Bagryany' cultivar.

The fertilizer backgrounds were selected considering the biomass accumulation capacity of amaranth and its demand for nutrients. The gradual increase in nitrogen, phosphorus, and potassium rates made it possible to objectively identify the plant response to mineral nutrition. The obtained results showed that, with increasing fertilizer rates, the vegetative organs of amaranth developed more actively, leafiness increased, and total plant weight rose. At the same time, it was observed that a high nutrition background does not always provide the maximum economic effect.

Table 1 Effect of Mineral Fertilizer Rates on Biometric Parameters of Amaranth

Variant	Fertilizer rate	Plant height, cm	Number of leaves, pcs.	Leaf weight, g/plant	Individual plant weight, g
1	Control	148.6	18.4	212.7	586.3
2	$N_{60}P_{45}K_{30}$	162.8	22.7	268.5	694.8
3	$N_{90}P_{60}K_{45}$	174.9	26.3	321.4	781.6
4	$N_{120}P_{90}K_{60}$	181.7	28.1	348.9	836.5

According to the data presented in Table 1, mineral fertilizer rates had a positive effect on the main biometric parameters of amaranth. In the control treatment, plant height was 148.6 cm, the number of leaves was 18.4, leaf weight was 212.7 g per plant, and individual plant weight was 586.3 g. In the treatments with mineral nutrition, these indicators increased gradually.

In particular, under the $N_{60}P_{45}K_{30}$ background, plant height increased to 162.8 cm, the number of leaves to 22.7, leaf weight to 268.5 g per plant, and individual plant weight to 694.8 g. In the $N_{90}P_{60}K_{45}$ treatment, further improvement was observed: plant height reached 174.9

cm, the number of leaves was 26.3, leaf weight was 321.4 g per plant, and individual plant weight was 781.6 g.

The highest biometric indicators were recorded under the N₁₂₀P₉₀K₆₀ treatment. In this variant, plant height reached 181.7 cm, the number of leaves was 28.1, leaf weight was 348.9 g per plant, and individual plant weight was 836.5 g. This indicates the high responsiveness of amaranth to mineral nutrition, especially under the combined application of nitrogen, phosphorus, and potassium.

Thus, increasing mineral fertilizer rates enhanced the vegetative growth of amaranth, promoted better formation of the leaf apparatus, and increased individual plant weight. According to biometric indicators, the most favorable result was obtained under the N₁₂₀P₉₀K₆₀ treatment.

Table 2 Effect of Mineral Fertilizer Rates on Amaranth Yield

Variant	Fertilizer rate	Green biomass yield, t/ha	Increase in green biomass, t/ha	Grain yield, t/ha	Increase in grain yield, t/ha
1	Control	31.4	–	1.78	–
2	N ₆₀ P ₄₅ K ₃₀	38.7	7.3	2.14	0.36
3	N ₉₀ P ₆₀ K ₄₅	44.8	13.4	2.53	0.75
4	N ₁₂₀ P ₉₀ K ₆₀	47.6	16.2	2.71	0.93

According to the data presented in Table 2, mineral fertilizer rates had a significant effect on the green biomass and grain yield of amaranth. In the control treatment, green biomass yield was 31.4 t/ha, while grain yield was 1.78 t/ha. In the treatments with mineral nutrition, these indicators increased consistently.

Under the N₆₀P₄₅K₃₀ treatment, green biomass yield reached 38.7 t/ha, providing an increase of 7.3 t/ha compared with the control. Grain yield reached 2.14 t/ha, increasing by 0.36 t/ha relative to the control treatment.

In the N₉₀P₆₀K₄₅ treatment, green biomass yield was 44.8 t/ha, the increase in green biomass was 13.4 t/ha, grain yield was 2.53 t/ha, and the increase in grain yield was 0.75 t/ha.

The highest yield indicators were recorded under the N₁₂₀P₉₀K₆₀ treatment. In this variant, green biomass yield reached 47.6 t/ha, which was 16.2 t/ha higher than the control. Grain yield was 2.71 t/ha, while the increase in grain yield was 0.93 t/ha. These results confirm the positive response of amaranth to mineral nutrition, especially under the combined and increased application of NPK.

Overall, with increasing mineral nutrition rates, both green biomass and grain yield of amaranth increased. However, although the biological maximum was obtained under the N₁₂₀P₉₀K₆₀ treatment, from the standpoint of fertilizer costs and return on additional yield, the N₉₀P₆₀K₄₅ treatment can also be considered economically feasible. Therefore, the results of this table confirm the important role of mineral nutrition in forming amaranth productivity.

Conclusion

Mineral nutrition had a positive effect on the growth and yield of amaranth. As fertilizer rates increased, plant height, number of leaves, leaf weight, and individual plant weight increased consistently. The biologically highest results were recorded under the N₁₂₀P₉₀K₆₀ treatment.

In terms of yield indicators, the maximum results were also observed under the $N_{120}P_{90}K_{60}$ treatment. However, the results of economic analysis showed that the $N_{90}P_{60}K_{45}$ background is the most optimal option, ensuring a balance between biological and economic efficiency. During the growing season, biomass accumulation in amaranth gradually intensified. A particularly intensive increase in plant height, individual plant weight, and dry matter content was observed during the 40–80-day vegetation period. It was established that the main share of amaranth green biomass yield is formed during the 60–80-day vegetation period. According to the results of correlation analysis, a strong positive relationship was identified between plant height, leaf weight, individual plant weight, and green biomass yield. In particular, individual plant weight was confirmed as one of the most important biometric criteria for evaluating and predicting the green biomass yield of amaranth.

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