International Journal of Multidiscipline

TLEP – International Journal of Multidiscipline
(Technology, Language, Education, and Psychology)
ISSN: 2488-9342 (Print) | 2488-9334 (Online)

Open Access | Peer-Reviewed | Monthly Publication | Impact factor: 8.497 / 2025

The Influence Of Sowing Schemes And Feeding Rates On Grain Yield Of Amaranth

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Annotation
This article presents the results of a study on the effect of different planting schemes, mineral fertilizer background and foliar feeding rates on the grain yield of amaranth variety IKBA-TDAU 2. The experiment used planting schemes 70×15–1, 70×20–1, 70×25–1 and 70×30–1 and fertilizer rates $N_{250}P_{175}K_{125}$, $N_{200}P_{140}K_{100}$ and $N_{150}P_{105}K_{75}$, as well as foliar feeding rates with water-soluble complex fertilizer Akvarin-14 during different vegetation periods. According to the results obtained, it was found that grain yield was higher in variants with reduced mineral fertilizer rates and combined with foliar feeding, depending on the planting schemes. In particular, the highest grain yield was obtained in the variant planted in the 70×25–1 planting scheme and foliar fed with water-soluble complex fertilizer Akvarin-14 ($N_{20}P_{20}K_{20}$) at the rate of + 1.4 kg/ha in the 5-6 leaf stage, 1.8 kg/ha in the tillering period, and 1.8 kg/ha in the grain formation period, on the background of mineral fertilizers $N_{150}P_{105}K_{75}$ kg/ha.
Keywords: amaranth, planting scheme, mineral fertilizer rate, foliar feeding period and rate, grain yield.

INTRODUCTION

Amaranth crops have gained special importance in agriculture in recent years as a crop with high nutritional value, especially resistant to stress factors and high economic efficiency. In particular, grain varieties of amaranth are an important raw material for food, animal husbandry and the processing industry. In this regard, it is relevant to study on a scientific basis agrotechnical measures such as planting schemes, mineral fertilizer rates and foliar feeding to increase the yield of amaranth varieties.

Amaranth is one of the oldest crops on earth, and its name, translated from Greek, means “unfading flower”. Researchers, in particular V.A.Zalman, emphasize that amaranth was one of the most important food sources for the indigenous Indians of South America in 5000 BC. It is also noted that this plant was first brought to Europe in 1885 by the Spanish botanist O.V. Tome [2; 175 p.].

Amaranthus cruentus species are widely cultivated. Due to their early maturity and ability to survive in intercropping with other crops, they remain the most preferred crop for early income and survival by many farmers, while farmers wait for other crops to mature in traditional natural intercropping systems. Amaranthus cruentus is grown in various cropping systems in home gardens, farms, inland valleys (fadams) and in suburban gardens [10; 289-293-p], [11; 29-35-p].

Amaranth is also known as African spinach, bush greens, spinach greens, etc. Amaranths belong to the Amaranth family. There are numerous species and cultivars of Amaranths. Many hybrids are found among the amaranths and are recognized as separate species. There are two types of amaranths, namely vegetable and grain amaranths [13; 85-96-p.].

Also, F.A. Mustafakulov et al. noted that amaranth has been cultivated in some regions of our republic for more than a hundred years, noting that it contributes to the restoration of soil and an increase in the amount of nutrients in some eroded areas [4; p. 205–209]. At the same time, according to A. Safarov et al. [5; p. 30–32], as well as N. Guljahon, the roots of the amaranth variety "Gultojikhuroz" penetrate deep into the soil, reducing water evaporation and protecting the soil from salinization [9; p. 334–338].

According to P.F. Kononkov and others, the current climate change is causing drought, and in the arid conditions of Ukraine, planting amaranth will lead to high efficiency. As a result, it will be possible to obtain a seed yield of up to 2 t/ha from these lands [3; p. 296].

According to P.B. Tillman, amaranth is very demanding on soil nutrients. In particular, the sufficient supply of nitrogenous nutrients leads to an increase in its yield, as well as an increase in the amount of protein in its content. He noted that for amaranth, a ratio of nutrients to nitrogen of 1:07:05 provides a yield of 19.9 t/ha [12; p. 1960–1964].

According to I.R. Askarov and others, the Uzbek, Markhamat, Andijan and Ulug'nor varieties of amaranth have been created in our republic and are distinguished by their original composition. The leaves, stems, flowers and seeds of this plant are rich in many useful organic and inorganic compounds [1; p. 232-236]. According to P.E Akin-Idowu and others [6; p. 1802–1810], D.M. Brenner [8; p. 104–106], L. Alvarez-Jubete and others [7; p. 240–257], in addition to its medicinal properties, amaranth is considered a food and fodder crop all over the world, and a lot of scientific research has been carried out and is being carried out on it.

MATERIALS AND METHODS

Field experiments were conducted in the experimental farm of Tashkent State Agrarian University in the Kibay district of Tashkent region in 2023-2025 under typical sierozem soil conditions. The design, implementation of field experiments, phenological observations, biometric measurements and other analyses were carried out based on the methods of "Methods of conducting field experiments" (2007), "Methodology of field experiments" (1985), "Methodology of field experiments with fodder crops" (1974), soil and plant analyses were carried out based on the methods of "Methods of agrochemical, agrophysical and microbiological studies in irrigated cotton areas" (1963), "Zootechnical analysis of fodder" (1989), "Methodology of agrochemical studies" (1989). The objects of the research were typical gray soils of the Tashkent region, the IKBA-TDAU 2 variety of amaranth, mineral fertilizer standards, water-soluble complex fertilizer "Akvarin-14" ($N_{20}P_{20}K_{20}$) and its application rates.

RESULTS AND DISCUSSION

The research studied the grain yield of amaranth in 2023–2025 depending on the planting schemes, fertilization rates and foliar feeding periods. The data in Table 1 below include the control variant of the experiment and the variants in which two different mineral fertilizer rates and foliar feeding were used. According to it, the first background was provided with mineral fertilizers at the rate of ($N_{250}P_{175}K_{125}$) and additional foliar feeding was not used. The results of the amaranth planting schemes 70x15-1, 70x20-1, 70x25-1 and 70x30-1 were studied on this background. The grain yield in the study in 2023 was in the range of 21.4–23.3 c / ha. The lowest indicator was 21.4 q/ha in the 70x15-1 scheme, while the highest result was 23.3 q/ha in the 70x20-1 scheme. This indicates that this is due to competition between plants and the availability of fodder. In the second year of the study, in 2024, the yield in the control variants slightly increased or remained stable. In particular, the yield in the 70x15-1 scheme was 22.1 q/ha, and in the 70x25-1 scheme 23.6 q/ha. In 2025, the indicators were relatively stable, ranging from 21.7 to 22.6 q/ha. Against this background, if we look at the three-year average yield, the highest result in the control variants was observed in the 70x25-1 scheme, which amounted to 22.9 s/ha. At the same time, the 70x20-1 scheme had 21.7 q/ha, the 70x30-1 scheme had 22.6 q/ha, and the lowest indicator was 21.7 s/ha in the 70x15-1 scheme. These results prove that the regulation of planting density is an important factor for amaranth grain yield. The second background of the experiments presents options in which mineral fertilizers were applied at the rate of $N_{200}P_{140}K_{100}$, and additional foliar feeding with Akvarin-14 ($N_{20}P_{20}K_{20}$) fertilizer was carried out. Foliar feeding was carried out at the rate of 1.4 kg/ha in the period of 5–6 leaflets, and 1.8 kg/ha in the period of panicle formation. Against this background, the grain yield in these options in the first 2023 was in the range of 22.9-24.4 q/ha. The highest indicator was 24.4 q/ha in the 70x25-1 scheme. In 2024, the yield increased further and was recorded in the range of 24.1-25.1 q/ha. It is especially noteworthy that the 70x25-1 scheme yielded 25.1 q/ha of grain. This trend was maintained in 2025: the yield was around 23.5-24.8 s/ha. Analysis of the three-year average indicators obtained shows that the grain yield in the variants using the $N_{200}P_{140}K_{100}$ rate and foliar feeding was significantly higher than in the control. In particular, the average yield was 23.5 q/ha in the 70x15-1 scheme, 24.2 q/ha in the 70x20-1 scheme, 24.8 q/ha in the 70x25-1 scheme, and 23.8 q/ha in the 70x30-1 scheme. The difference compared to the control was in the range of +1.53-1.77 q/ha, which clearly indicates the positive effect of foliar feeding.

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Table 1. Grain yield of amaranth varieties depending on sowing schemes, fertilization rates, and foliar feeding periods, q/ha, 2023-2025 yy.

<table>
<tr><th>No</th><th>Sowing schemes</th><th>Fertilization rate</th><th>Date of foliar application</th><th>2023</th><th>2024</th><th>2025</th><th>Avarage</th><th>difference +,-</th></tr>
<tr><td>13</td><td>70x15-1</td><td rowspan="4">$N_{250}P_{175}K_{125}$</td><td rowspan="4">Control (treated with water)</td><td>21.4</td><td>22.1</td><td>21.7</td><td>21.7</td><td>-</td></tr>
<tr><td>14</td><td>70x20-1</td><td>22.9</td><td>22.5</td><td>22.4</td><td>22.6</td><td>-</td></tr>
<tr><td>15</td><td>70x25-1</td><td>23.3</td><td>23.6</td><td>22.6</td><td>23.2</td><td>-</td></tr>
<tr><td>16</td><td>70x30-1</td><td>22.2</td><td>22.8</td><td>21.9</td><td>22.3</td><td>-</td></tr>
<tr><td>17</td><td>70x15-1</td><td rowspan="4">$N_{200}P_{140}K_{100}$</td><td rowspan="4">Aquarin-14 ($N_{20}P_{20}K_{20}$) water-soluble complex fertilizer + 1.4 kg/ha in the 5-6 leaf stage, 1.8 kg/ha during the panicle formation stage</td><td>22.9</td><td>24.1</td><td>23.5</td><td>23.5</td><td>1.77</td></tr>
<tr><td>18</td><td>70x20-1</td><td>23.6</td><td>24.9</td><td>24.2</td><td>24.2</td><td>1.63</td></tr>
<tr><td>19</td><td>70x25-1</td><td>24.4</td><td>25.1</td><td>24.8</td><td>24.8</td><td>1.60</td></tr>
<tr><td>20</td><td>70x30-1</td><td>23.2</td><td>24.5</td><td>23.8</td><td>23.8</td><td>1.53</td></tr>
<tr><td>21</td><td>70x15-1</td><td rowspan="4">$N_{150}P_{105}K_{75}$</td><td rowspan="4">Aquarin-14 ($N_{20}P_{20}K_{20}$) water-soluble complex fertilizer + 1.4 kg/ha in the 5-6 leaf stage, 1.8 kg/ha in the panicle formation stage, 1.8 kg/ha in the grain formation stage</td><td>24.2</td><td>25.0</td><td>24.8</td><td>24.7</td><td>2.93</td></tr>
<tr><td>22</td><td>70x20-1</td><td>25.2</td><td>25.5</td><td>25.6</td><td>25.4</td><td>2.83</td></tr>
<tr><td>23</td><td>70x25-1</td><td>26.3</td><td>26.5</td><td>26.1</td><td>26.3</td><td>3.13</td></tr>
<tr><td>24</td><td>70x30-1</td><td>24.5</td><td>25.9</td><td>25.8</td><td>25.4</td><td>3.10</td></tr>
</table>

The third background of the experiment showed high efficiency of foliar feeding at the rate of $N_{150}P_{105}K_{75}$, where the amaranth crop was given basic fertilizers at the rate of $N_{150}P_{105}K_{75}$ and foliar feeding with Akvarin-14 fertilizer was carried out in three stages: 1.4 kg/ha in the period of 5-6 leaflets, 1.8 kg/ha in the period of panicle formation and 1.8 kg/ha in the period of grain formation. In 2023, the average grain yield on this background was in the range of 24.2–26.3 q/ha, and the highest indicator was 26.3 q/ha in the 70x20-1 scheme.

In the 2024 study, the yield increased further and reached 25.0–26.5 q/ha. In particular, the table clearly shows that the 70x25-1 scheme yielded 26.5 q/ha.

High results were maintained in 2025, with yields in the range of 24.8-26.1 q/ha. The three-year averages prove the absolute superiority of these options. In particular, the 70x15-1 scheme yielded an average of 24.8 q/ha, the 70x20-1 scheme 25.6 q/ha, the 70x25-1 scheme 26.1 q/ha, and the 70x30-1 scheme 25.8 q/ha. When analyzing the differences between the options against this background, the difference compared to the control option was +2.83–3.13 q/ha, which indicates that the optimization of the mineral fertilizer rate and the combined use of foliar feeding dramatically increase amaranth grain yield.

When comparing the planting schemes of amaranth in the studies, it is clear from the data that the most stable and high results in all fertilization and feeding options were recorded mainly in the 70x25-1 planting scheme. This scheme creates sufficient nutrient space for plants and creates favorable conditions for the development of the root system and above-ground part.

In the planting scheme 70x15-1, due to the high plant density, competition for nutrients increased and, as a result, the yield was relatively low. In the 70x30-1 scheme, despite the large nutrient space, the total yield was lower than in the 70x25-1 scheme due to the reduced number of plants.

CONCLUSION

The results of the conducted studies showed that the grain yield of amaranth is very sensitive to the planting scheme, fertilization rate and foliar feeding. In the control variant, the highest average yield was 23.2 q/ha, while in the variants where foliar feeding was used, this indicator increased to 24.8-26.3 q/ha. The highest and most stable results were obtained against the background of the 70x25-1 planting scheme and the rate of mineral fertilizers $N_{150}P_{105}K_{75}$ kg/ha, with three-stage foliar feeding with the water-soluble complex fertilizer Akvarin-14. This agrotechnical method allowed to increase the grain yield of amaranth by 3.13 q/ha compared to the control. Therefore, when growing amaranth variety IKBA-TDAU 2, it is recommended to plant it in a 70×25–1 planting scheme and apply foliar feeding with water-soluble complex fertilizer Akvarin-14 ($N_{20}P_{20}K_{20}$) at the rate of + 1.4 kg/ha in the period of 5-6 leaflets, 1.8 kg/ha during the panicle formation period, and 1.8 kg/ha during grain formation against the background of mineral fertilizers $N_{150}P_{105}K_{75}$ kg/ha.

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