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Issue Article

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METHODS OF DEVELOPING AGROTECHNOLOGY OF AMARANTH PLANT UNDER ORGANIC FARMING CONDITIONS

***Abstract**: Amaranth is considered a useful plant. Among the many crops around the world, it is in the top ten in terms of the number of cultivars. In arid conditions and with a shortage of irrigation water and increasing desertification of the region, the use of traditional plants (cotton, wheat, rice and other crops) becomes problematic due to greater water consumption and requirements for cultivation conditions. According to American scientists, amaranth, when assessing the biological activity of protein 100 points, protein in amaranth grain is estimated at 75 points, wheat protein - 56.9 points, soybean grain - 68, cow's milk - 72.2 points. organic fertilizers on the growth and development of amaranth. The study of the characteristics of the growth and development of amaranth at different rates of application of organic and mineral fertilizers, a positive effect of organic fertilizers on the growth and development of amaranth has been established.*

***Key words**: amaranth, agrotechnology, organic fertilizer, mineral fertilizer, soil composition, growth period, flowering, grain.*

***Language**: English*

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Introduction

Currently, in the conditions of the increase in the average temperature around the world and the disturbance of the ecological balance, there is also a shortage of water and an increase in saline cultivated areas in Karakalpakstan. This, in turn, shows the need to cultivate plants that are stable to stress conditions and require less water and apply them to various sectors of the national economy. One of such non-traditional types of plants is Amaranthus.

Amaranth (from the Greek - eternal, unfading) – it is a new culture for our country, which attracts the attention of researchers and agricultural practitioners for its richness and balance of protein, surprisingly high yield, abundance of vitamins and mineral salts. In the 21st century, this plant is able to take a leading position not only as food and fodder, but also as a medicinal plant. In addition, due to the expected global climate changes on Earth [1], the use of amaranth is increasing and is more relevant due to its characteristics to adapt to different environmental conditions. Since this culture is still little known, the purpose of the article is to familiarize the reader with the specificity of amaranth biology and physiology, especially in relation to its high adaptive potential.

Amaranth protein contains twice as much lysine as wheat, and three times as much as corn and sorghum. It is known that lysine is a valuable essential amino acid, because it cannot be synthesized in animal tissues, humans and animals get it only from plants. Amaranth seeds are also a source for the production of vegetable oil and squalene [3]. 100 grams of amaranth seeds have 370 calories and contain 7 grams of lipids, 4 mg of sodium, 508 mg of potassium, 65 mg of carbohydrates, 1.7 mg of sugar, 14 mg of protein, 159 mg of calcium, 4.2 mg of vitamin C, 7.6 mg of iron, 248 mg of magnesium, 0.6 mg of vitamin V6, and other vitamins are found. Amaranth oil does not contain cholesterol (N. B. Zheleznova, A. V. Zheleznov, V. K. Shumnyi i dr., 1989; E. A. Goncharova, 2001; Baranova T.V., 2012).

Amaranth seeds are widely used in the treatment of a number of diseases. In our republic, the use of amaranth plant products began to be cultivated mainly for fodder crops. Medicinal properties of the plant are being studied by the medical staff of our republic and scientific information on scientific basis is being found, at the same time there is information that it has been widely used in our national medicine since ancient times (Tursunova Sh.A., 2019; Eryigitova S., Pazilbekova Z., 2021).

Growing amaranth as an agricultural crop in the conditions of the Republic of Karakalpakstan, taking into account the lack of published scientific data on this plant, the purpose of studying the growth and development of plants of two types of lines when using amaranth as a main and repeated crop at different rates of organic and mineral fertilizers was set. In the field experiments, the tasks of collecting data on two types of lines were set in the variants given different organic and mineral fertilizers;

- to determine the dynamics of accumulation of green and dry matter according to development phases;
- check leaf area dynamics and photosynthetic efficiency;
- taking into account the accumulation of green mass of the plant;
- determination of grain yield and yield structure;
- to determine the productivity of amaranth green mass and grain grown in saline and dry areas and to recommend alternative options for production.

The technology of growing amaranth in the experiment. Fields where amaranth is planted were plowed to a depth of 25-35 cm in autumn and leveled. Before plowing the soil, depending on the options, organic and mineral fertilizers are spread, weeding is done. Amaranth planting was carried out in March-April, when the soil warmed up to 10-12 degrees and the soil was ready for planting. Amaranth was planted in two periods on April 16 and May 2 in a 60x20 scheme. Two different cultivar samples were planted and tested, they are Red flower and Blue flower cultivar samples. They are distinguished by their resistance to local saline soils and annual droughts and water shortages. Amaranth seed consumption was 1.0 kg per hectare, planting depth was about 1.5 cm. When sowing the seeds, a small slave was planted with a seeder. Baranova T.V. According to (2012), it is recommended that the seed consumption per hectare can be up to 2 kg per hectare when grown as animal feed.

When the height of the plants reached 10-15 cm, the rows were loosened with a cultivator to a depth of 5-6 cm and fed with ammonium nitrate at the rate of 40 kg/ha per one hectare of land. The second feeding was carried out with nitrogen and phosphorus fertilizers at the rate of 30 kg/ha per hectare before watering when the plant reached 30-35 cm in height. After feeding, the growth and development of amaranth accelerates (Chernov I.A., 1992; Chirkova, T. V., 1999). During the season, the soil was irrigated mainly once in 2021 and twice in 2022, depending on the climatic and economic conditions. The soil composition of amaranth field is presented in Table 1. Nitrates were observed to be the highest before planting at 26.56 mg/100 grams of soil. During the growing season, plants use nitrates to decrease; and the amount of ammonium nitrogen, phosphates and humus increases in the soil at the end of vegetation.

Table 1. Amaranth field soil composition (2021), mg/100 grams

options	nitrates	ammonium	phosphates	hummus	pH
Until planting (april)	26.56	1.99	1.168	1.014	7.2
Flowering (june)	9.57	1.92	1.174	0.95	7.4
Ripe (september)	18.68	8.44	3.148	1.144	7.1

Mathematical analysis of the obtained results B.A. It is processed according to the methodology of Dospekhov (1985).

The obtained results and their analysis. Data obtained on phenological observations are presented in table 2. The time of emergence of sprouts was observed simultaneously in all options given organic and mineral fertilizers. The next phase of development: by the time of the appearance of 4-5 pairs of leaves, it was observed that in the variants given mineral and organic fertilizers, this period was two days earlier than in the control (fertilized) variant. In the variant planted in the second term (May 1), the same effect of fertilizers was observed, and the time of appearance of 4-5 pairs of leaves fell on May 25 for red-flowered amaranth and May 28 for brown-flowered amaranth.

Table 2. Amaranth transition from phenological phases according to planting dates and fertilization rates

Phases of development	1 term (15 aprel)			2 term (1 may)		
Planting	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha
Complete sprouts	23.04* 23.04**	23.04 23.04	23.04 23.04	06.05 08.05	06.05 08.05	06.05 08.05
4-5 pairs of leaves	11.05 13.05	13.05 15.05	13.05 15.05	23.05 26.05	25.05 28.05	26.05 29.05
Beginning of branching	19.05 21.05	21.05 24.05	21.05 24.05	29.05 30.05	31.05 04.06	31.05 04.05
Branching and spike production	05.07 08.07	08.07 10.07	08.07 10.07	15.07 18.07	18.07 20.07	18.07 20.07
bloom	15.07 20.07	18.07 22.07	18.07 22.07	21.07 23.07	23.07 25.07	24.07 26.07
Fruiting	10.08 13.08	13.08 15.08	13.08 15.08	12.08 17.08	15.08 20.08	15.08 20.08
Full ripening	During the reporting period, this phase was not observed in plants					
collection						

*amaranth variety specimen with red flowers; **amaranth variety specimen with blue flowers

The beginning of the branching phase was observed on May 19-21 in the control option when planted in the 1st period (April 15), May 21-24 in the fertilized options, and July 18-20 when planted in the second period. The phase of branching and earing was observed in plants planted in the first period on July 8-10, and in the second planting period on July 18-20. Flowering phase is the main and complex process, weather and agrotechnical conditions during this period affect grain yield. It is worth mentioning that due to the shortage of irrigation water in the 2022 growing season, it has been shown to have a negative effect on seed set during the flowering period of plants. Therefore, we believe that the above-normal temperature in July had a bad effect on the growth of the development phases. The fruiting phase was observed on August 13-15 in the first planting period, and on August 15-20 in the second planting period.

Leaf area and dry matter accumulation in amaranth crops. The process of photosynthesis plays an important role in the accumulation of dry matter and productivity. The process of photosynthesis in plants changes during the day and during the growing season, as well as depending on the type of plant and the applied agrotechnical measures (Khujaev J.Kh., 2004).

Table 3 shows the information about leaf fall of amaranth crops according to the variants of our experiment. Maximum leaf fall is observed between branching and spike-flowering phases.

According to the data (Shugusheva L.Kh., 2015), the loss of phenophases, the intensity of plant growth and the accumulation of dry matter in ontogeny, the additional daily growth of the stem and the continuation of the vegetative period depend on the individual characteristics of plants and growing conditions.

In our experiments, the most favorable growth conditions are observed when mineral and organic fertilizers are applied to the soil. During ontogeny, the growth of the highest stem takes place between the budding and flowering phase. In this case, the highest results were observed in the variants planted in 1 period (April 15), when mineral fertilizer $N_{150}P_{80}K_{60}$ was given, the average leaf area of one plant was 1046.19 sm^2 (table 3), and 984.6 sm^2 for red flower amaranth. Organic fertilizer 25 t/ha leaf in the given option.

Table 3. Leaf area (sm^2) and dry matter accumulation (t/ha) of one plant depending on the planting dates and fertilization rates of amaranth

Phases of development	1 term (15 aprel)			2 term (2 may)		
	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha
Leaf area a plant, average (sm^2)						
Branching and spike - flowering	329,5 287,2	1046,19 984,6	1138,1 1053,6	307,4 286,8	1022,6 973,5	1061,5 1022,4
Grain formation phase	186,7 147,4	484,8 464,7	479,2 459,1	176,4 170,6	439,5 420,8	442,9 427,3
Dry mass of a plant (weight, gr)						
Branching and spike - flowering	305,2 285,3	440,0 421,6	437,2 429,0	316,7 290,5	423,0 401,5	425,2 406,0
Grain formation phase	270,4 251,6	336,0 331,4	347,2 338,0	253,6 228,2	328,5 311,8	317,8 320,6

area was 1138,1 and 1053,6 sm^2 per plant (average in this order).

In plants planted in the second period (May 2), the increase in leaf area is observed to be less during the budding-flowering phase.

Dry matter is observed in the phase of budding, branching and earing-flowering in the amaranth plant. At the same time, in the first planting period, in the control (unstimulated) version, 305.2 grams of amaranth with red flowers and 285.3 grams were distributed in one plant of amaranth with red flowers. In the case of mineral fertilizer $N_{150}P_{80}K_{60}$ kg/ha, the average weight of one plant was 440.0 grams, and the weight of one red-flowered amaranth plant was 421.6 grams. In the case where organic fertilizer is given in the amount of 25 t/ha, it is the same: 437.2 and 429.0 grams.

Amaranth planted in the second period (on May 2) without fertilizer (control): 316.7 and 290.5 grams; mineral fertilizer $N_{150}P_{80}K_{60}$, in the version given in the norm, the amount of dry matter per plant is 423.0 and 401.5 grams. Organic fertilizer at the rate of 25 t/ha did not significantly differ: 425.2 and 406.0 grams of dry matter per plant.

Green mass yield of amaranth. According to the data of L.A. Miroshnichenko (12), according to the data of the Belarusian Research Institute of Animal Husbandry, when using a mixture of corn and amaranth silage, milk yield and milk viscosity were higher than when feeding only corn silage. Milk yield + 24.9%, fat content increased by 0.12%, protein content in milk increased by 0.25%. There are reports that it is useful to harvest amaranth green mass for silage during the flowering phase. Amaranth fodder has a higher biological productivity than other forages. Green mass productivity of amaranth is at least 20-30% higher than that of maize and has been proven to give green mass yield of 500 t/ha and more in other regions. In irrigated lands, it can produce twice a year.

Amaranth biomass is a vitamin-rich fodder that is easily absorbed by the animal body. Since the content of protein is 19 - 21%, it is used to correct the quality of other fodder, for example, animal fodder is supplemented with all the elements in terms of protein (8). Adding only 10-15% additional amaranth meal allows to increase the productivity of farm animals without spending too much money.

Taking into account the importance of amaranth silage mentioned above, the yield of silage mass grown according to options in the experimental fields is presented in table 4.

Table 4. Green mass yield of amaranth (July 15, 2022 y)

Phases of development	1 term (15 aprel)			2 term (2 may)		
	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha
on average per plant, gram						
Amaranth with blue flower	972	1670	1588	951	1518	1574
Amaranth with red flower	896	1547	1519	926	1483	1522
	on average per hectare, ts/ha					
Amaranth with blue flower	880	1503,0	1429,2	855,9	1366,2	1416,6
Amaranth with red flower	806,4	1392,3	1367,1	833,4	1334,7	1369,8

According to the obtained data, the lowest green mass yield was obtained in the non-fertilized variant, the weight of one plant of White amaranth is 972 grams, and that of red amaranth is 898 grams. The green mass obtained per hectare is 880 and 806.4 centners in blue-flowered amaranth and red-flowered amaranth. When mineral fertilizers are given at the rate of $N_{150}P_{80}K_{60}$, the yield of green mass increases 1.71 times, and the yield per hectare of Blue-flowered amaranth is equal to 1503.0 t/h. In the variant with organic fertilizer at 25 t/h, the increase compared to the control is 1.62 higher and reaches 1429.2-1367.1 t/h.

Green mass yield in amaranth varieties planted in the second period was lower on July 15 compared to the first period, and it is observed that their maximum green mass accumulation time is 10 days later. Amaranth stalks have the ability to form strong and vigorous stems (Fig. 21-23).

Amaranth grain yield. Harvesting was done when the leaves turned yellow and the moisture content of the grain was around 16-18% (table 5).

According to the data, the lowest yield was observed in the non-fertilized version, 8.7 t/ha of amaranth with blue flowers and 7.3 t/ha of amaranth with red flowers. With an increase in the rate of mineral fertilizer, the yield in the $N_{150}P_{80}K_{60}$ variant was thus 19.7 and 19.2 t/ha. Organic fertilizer 25 t/ha

Table 5. Grain yield of amaranth (July 22, 2022 y)

Phases of development	1 term (15 aprel)			2 term (2 may)		
	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha	Fertilizer isn`t given (control)	Mineral fertilizer $N_{150}P_{80}K_{60}$	Organic fertilizer 25 t/ha
on average per plant, gram						
Amaranth with blue flower	8,7	19,7	17,5	8,1	18,3	17,0
Amaranth with red flower	7,3	19,2	17,2	6,7	17,6	16,4
HCP_{05}, ts\ga		0,7			0,6	

17.5 and 17.2 ts/ha grain yield was collected in the given option. It is necessary to take into account the reduction of grain yield in the case of organic fertilizer application, as only a part of the nutrients contained in organic fertilizer will be fully usable for plants in the first year.

In the options planted in the second term, it is observed that the grains of the plant are less ripe due to insufficient ripening. For example, it is observed that the yield in the second period for blue-flowered amaranth was lower by 0.9 centners on average, and for red-flowered amaranth it was lower by 1.0 t/ha.

In conclusion, amaranth yield in 2022 is close to annual figures. Fertilized varieties yield significantly higher and these indicators are 16.4-19.7 ts/ha. A significant difference is observed in the fertilized variants compared to the control variant and between planting dates.

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