Improving elements of sesame growing agrotechnology in the climate conditions of Khorezm province, Uzbekistan

Makhfurat Amanova[1,*], *Abdumalik* Rustamov[1] and *Behzod* Rustamov[1]

[1]Tashkent State Agrarian University, 2, University street, Tashkent, 100140, Uzbekistan

Abstract. In the agricultural landscape of Uzbekistan, an area of 15-18 thousand hectares is dedicated annually to the cultivation of sesame, serving as a supplementary source of income for many. The resulting sesame harvest is predominantly distributed within domestic markets, while a portion is earmarked for international export. The average sesame seed yield in Uzbekistan stands at 4-5 tons per hectare in rain-fed conditions and 8-14 tons per hectare in irrigated settings. In light of these circumstances, the core objective of this study is to ascertain the optimal timing, seeding rate, and cultivation technique for the production of premium-grade exportable sesame goods, uniquely tailored to the climatic conditions prevalent in the Khorezm province of Uzbekistan. By delving into these variables, researchers aim to uncover strategies that maximize the quality and quantity of sesame crops in Khorezm. Such insights hold the potential to not only enhance local production and export capabilities but also contribute to the agricultural economy of the region. By striving to identify the most effective practices, this study seeks to streamline the cultivation process, boost sesame yield, and elevate the overall agricultural landscape in the Khorezm province.

Keywords. Climatic conditions, sesame, planting dates, planting scheme, planting methods.

1 Introduction

Sesame is one of the main oil-producing plants and is grown in more than forty countries of the world, including Burma, India, China, Ethiopia, Sudan, Uganda, Nigeria, Somalia, Asia Minor, Caucasus, Iran, Central Asia, Afghanistan, Far East, Japan, Southern Europe, It is widely grown in America, Mexico and Peru [1-3].

According to Internet data, the price of a ton of sesame seeds has risen sharply from $1,000 to $3,000 in the world market in the last five years [4]. The main reason for this is the prolonged drought in the last (5-7) years in the African sesame-growing countries [5].

In Uzbekistan, 15-18 thousand ha of sesame are grown annually for additional income. The main part of the grown product is sold in our domestic markets, and the rest is

* Corresponding author: makhfurat.amanova1001@mail.ru

exported. In Uzbekistan, the average productivity of sesame seeds is 4-5 t/ha in dry land and 8-14 t/ha in irrigated land [6].

In order to grow a high-quality sesame crop in Uzbekistan and increase the export potential in the world market, it is necessary to organize the primary and variety seed production of regionalized sesame varieties, to continuously provide farmers with quality seeds, and to properly introduce the agrotechnology of cultivation [7-9].

Sesame is not only the main oil-giving plant, but it is also distinguished from other oil-giving plants by its healing properties. In eastern countries, fresh sesame leaves and twigs are used to make delicious salads, rich in vitamins and minerals, white, creamy, light yellow sesame seeds, and ointments are used to treat stomach and intestinal ulcers and body burns. Tachin prepared from sesame was eaten with honey to increase tolerance [10].

Sesame has been cultivated in Central Asia for several thousand years. However, during the former Soviet Union, the Republic of Uzbekistan mainly specialized in cotton. The demand for vegetable oil is covered by cottonseed oil [11].

In Central Asia, the Central Asian branch of VIR (All-Union Institute of Plant Science), currently the Research Institute of Plant Genetic Resources, dealt only with sesame. More than 1,750 varieties of sesame introduced from more than 50 countries of the world are kept alive in this place. Z.A.Luzina, A.Cherkov, B.Amanturdiev on the systematics, biology, selection, seed production, diseases and agrotechnology of sesame plant since 1924 in this place (in the climatic conditions of Tashkent region), researches were conducted [12]. However, no research has been conducted in the saline soil conditions of Khorezm region.

In order to provide the population of Uzbekistan with a wide range of sesame products (sesame oil, tahini, kholva and seeds), the development and introduction of high-quality harvesting technology is one of the urgent issues of today. Therefore, the purpose of the study is to determine the optimal planting period, rate and method for growing high-quality exportable sesame products in the climatic conditions of Khorezm region.

2 Materials and methods

The research was carried out on the basis of "Research of the world collection of oilseeds" [10] and statistical analysis based on the method of B.A. Dospekhov [6].

The Khorezm oasis, one of the northern regions of Uzbekistan, is located in the northern part of the wide Turanian plain, which covers the plains of Central Asia. It occupied the left bank of the ancient Amudarya delta. Its eastern border is the Toshsaka plateau, and its western border is with Turkmenistan. According to its geographical location, Karakalpakstan and Khorezm region are located in the northern part of Uzbekistan. These areas fall into a very dry region, with an annual rainfall of 80-90 millimeters, and they fall mainly in winter and spring. The climate of the oasis is sharply continental. Summer is hot and dry. In July, the average air temperature is +28°C, the average absolute high temperature is +41°C, sometimes the temperature reaches +46°C.

The peculiarity of the Khorezm oasis is that it has sufficient light and heat, continental variability and dry air. The duration of sunlight is 2700–3000 hours per year, with 360–400 hours of sunlight per month in summer and 90–130 hours in winter. The variability of temperature in one day is high (10–15 ^{0}C in winter and 15–20 ^{0}C in summer).

The soil is gray soil , the groundwater is located at a depth of 1.5-1.7 meters and is highly saline. Generally, fields with agricultural crops other than rice are washed three or four times each year. The experimental field was washed twice in the winter and spring of 2022 because the predecessor plant was rice.

Agrotechnical activities carried out in the research field. Before planting, ammophos was given at 200 kg per hectare. During the growth period, 2 times cultivation, 1 time mulching and 2 times foliar feeding with micro and biofertilizers.

The climatic conditions of the Khorezm region are unique, and the method of sesame cultivation is clearly different from the regions near the Amudarya and the regions far from the river. The experimental field of 2022 was located near the shores of the Amudarya, and the groundwater was at a depth of 1.5-2 m and was highly saline.

3 Results and discussion

Sesame seeds of "Black Prince", "Tashkentsky 122", promising "Kiva" and "Urganch" varieties at different planting dates (April 30, May 10, May 20, and May 30) in 3.5 m 2 experimental plots with [4] replications planted. The plants were singled according to the feeding area of 60x15 cm.

When sesame seeds were sown on April 30, it took 10-12 days for the seeds to germinate. The arrival of cool weather in the third ten days of April prevented the seeds from germinating evenly. As a result, the differences in the development of the plants were large, 20-22 percent of the plants ripened in the first, and after 8-9 days, 75-78 percent of the plants ripened.

When sesame seeds were sown on April 30, the growing season lasted 125 days in "Black Prince", "Tashkentsky 122" and "Urganch" varieties, and 115 days in "Kiva" variety. It was 17.2 t/ha in the 122" variety, 20.9 t/ha in the "Urganch" variety and 19.1 t/ha in the "Kiva" variety (Table 1).

Table 1. Effect of planting dates on the productivity of sesame varieties planted as a main crop, q/ha.

Varieties	Black prince	Tashkentsky-122	Kiva	Urganch
April 30				
Growth period, days	125	125	115	125
Yield, q/ha	20.2	17.2	19.1	20.9
Weight of 1000 seeds, g	3.1	2.6	2.9	3.1
May 10				
Growth period, days	120	120	11 2	120
Yield, q/ha	21.3	18.4	19.3	22.9
Weight of 1000 seeds, g	3.12	2.65	2.9	3.1
May 20				
Growth period, days	132	132	125	132
Yield, q/ha	18.1	16.5	16.1	19.6
Weight of 1000 seeds, g	3.0	2.56	2.8	3.0
May 30				
Growth period, days	135	135	125	135
Yiel, q/ha	16.1	14.7	14.3	16.4
Weight of 1000 seeds, g	2.91	2.5	2.75	3.0

When the seeds were sown on May 10, they took 6-7 days to fully germinate. It took 6-7 days for the seeds to fully germinate.

The growing season lasted 120 days in "Black Prince", "Tashkentsky 122" and "Urganch" varieties, and 112 days in "Kiva" variety, and the average yield was 21.3 t/ha in "Black Prince" variety, 18, in "Tashkentsky 122" variety. 4 q/ha, 22.9 q/ha in "Urganch" variety and 19.3 q/ha in "Kiva" variety.

When sesame seeds were sown on May 20, the seeds germinated very quickly in 3-4 days. However, because the soil was dry, it was lightly watered by moistening the soil. For this, every 20 meters, a ditch was opened and water was poured.

In the field where the seeds were sown on May 20, the growing season lasted 132 days in the varieties "Black Prince", "Tashkentsky 122" and "Urganch", and 125 days in the variety "Kiva", the average yield in the variety "Black Prince" was 18.1.0 t/ha, It was 16.5 t/ha in "Tashkentsky 122" variety, 19.6 t/ha in "Urganch" variety and 16.1 t/ha in "Kiva" variety.

When sesame seeds were sown on May 30, seed water was also given and the seeds germinated in 3-4 days. However, below-normal average daily temperatures in late September and October slowed the development of tubers. In the field where the seeds were sown on May 30, the growing season lasted 135 days for the "Black Prince", "Tashkentsky 122" and "Urganch" varieties, and 125 days for the " Kiva " variety . The average productivity of the variety "Black Prince" is 16.1 t/ha, the variety "Tashkentsky 122" is 14.7 t/ha, the variety "Urganch" is 16.4 t/ha, and the variety " Kiva " is 14.8 made q/ha.

The effect of sesame planting time on seed weight was determined by weighing 1000 seeds on an electronic balance in laboratory conditions. The size of the seed depends on the characteristics of the variety, and it was observed that under the influence of the delay in the planting period, it caused a decrease in the weight of the seed, although it was a small amount **(**Figure 1).

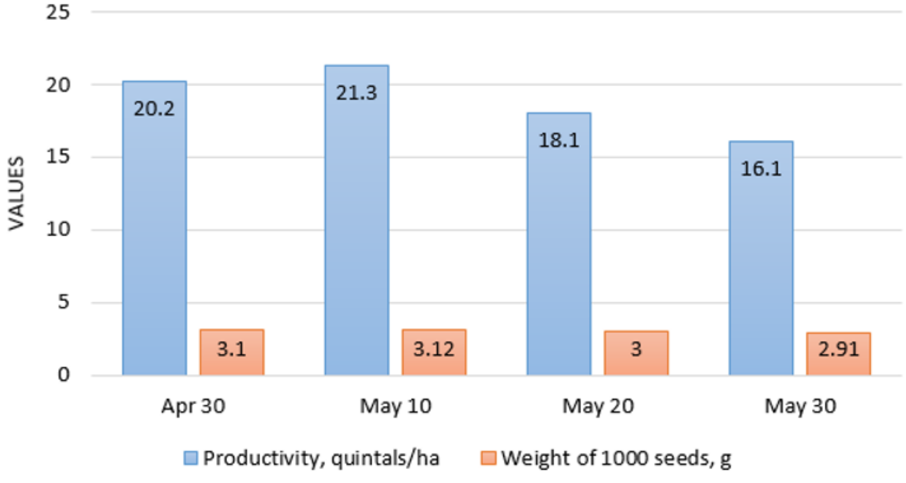

Figure 1. Dependence of productivity and weight of seeds on time periods.

Sesame varieties "Black Prince", "Tashkentsky 122" and "Urganch" are branching varieties, and plants developed well in the 60x15 cm feeding area due to the fact that one plant developed up to 3-4 side branches on average. It was observed that the yield of the " Kiva " variety was relatively low because it does not branch, and the crop is located in a spiral shape around the main stem. The non-branching feature of the Kiva variety makes it possible to plant it in double rows. By increasing the number of seedlings per unit area by 1.5-2.0 times, it is possible to increase productivity by 1.5 times.

We used the same method, that is, we planted the variety "Kiva" in double rows and increased the number of seedlings from 111,000 to 170,000 per hectare, and the average yield was 24.4 t/ha (Figure 2). In this case, the plants were 20 cm between the tapes, and the plants were left in a checkerboard pattern.

Figure 2. Kiva variety.

Another advantage of the " Kiva" variety of sesame compared to other varieties is the shorter growing period of 10-12 days. In the climatic conditions of the Khorezm region, the correct determination of planting dates is one of the most important factors in growing a high yield of sesame. Based on the results of our research, taking into account the recent short-term cold days that may occur in the Khorezm region, we determined that the optimal planting period for growing high-quality and exportable sesame in the local climate is May 1-10.

Sesame varieties were planted as a repeated crop in 10 June, 20 June, 1 July and 10 July in experimental plots of 3.5 m ^{2} with 4 replications, and the effect of sowing dates on yield was studied.

Sesame was irrigated and prepared for planting in the experimental field by side-draining before the land was prepared for planting. In June and July, the average air temperature was 28-29 ^{o} C, and the seeds began to germinate within 3-4 days after sowing. By the fifth day, the number of seedlings reached 75% (Table 2).

Table 2. Effect of planting dates on the productivity of sesame varieties planted as a repeated crop, q/ha.

Varieties	**Black Prince**	**Tashkentsky-122**	**Kiva**	**Urganch**
June 10				
Growth period , days	120	120	120	120
Yield ts /ha	8.5	7.4	7.2	8.5
June 20				
Growth period , days	1 25	125	1 25	125
Yield ts /ha	5.2	5.1	4.5	5.3
July 1				
Growth period , days	110	110	110	110
Yield ts /ha	3.4	3.1	3.1	3.4
July 10				
Growth period , days	90	90	90	90
Yield ts /ha	1.4	1.4	1.4	1.45

Sesame seeds Seeds were sown on June 10, "Black Prince", "Tashkentsky 122" and "Urganch" varieties, on October 20, after the leaves were completely shed, the lower pods began to open, the crop was harvested and spread on tarpaulins for drying. Due to the cool October, it took 15-18 days for the pods to fully open.

When the seeds were sown on June 10, the average yield was 8.5 t/ha in "Black Shahzoda" and "Urganch" varieties, 7.4 t/ha in "Tashkentsky 122" variety, and 7.2 t/ha in "Kiva" varieties. If so, these indicators are 5.2 t/ha of "Black Prince" on June 20, 5.1 t/ha of "Tashkentsky 122" variety, 5.3 t/ha of "Urganch" variety and 4.5 t/ha of "Kiva" variety. was obtained (Figure 3). When sesame seeds were sown on July 1, the seeds fully germinated in 3-4 days and the plants entered the flowering stage in August. The crop had to be harvested on October 20 before physiological ripening.

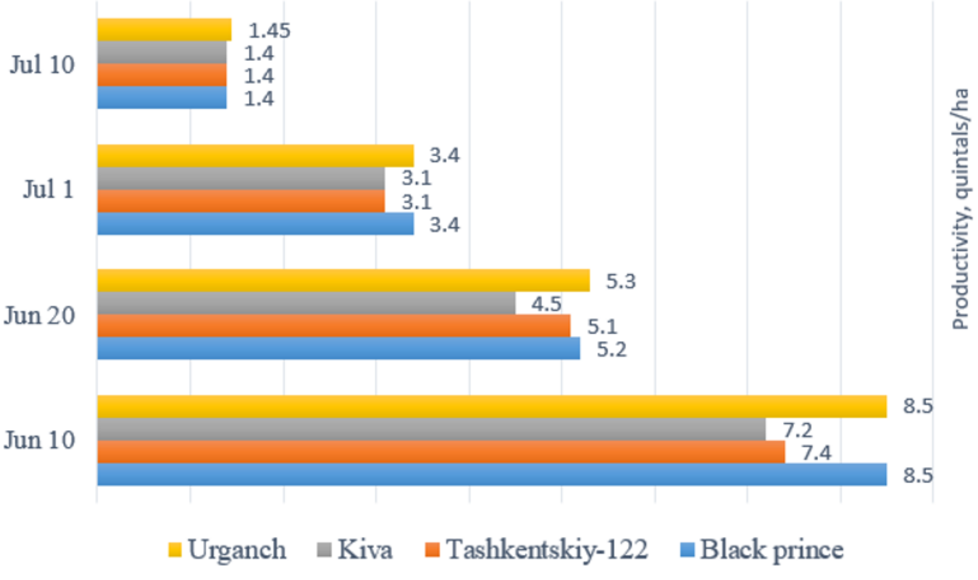

Figure 3. Productivity of different sesame varieties.

For forced germination of sesame seeds and in order to improve wind circulation during the drying period, the plants of each section were tied together and left in the open field. When the seeds were sown on July 1, the average yield was 3.4 t/ha in "Black Shahzoda" and "Urganch" varieties, and 3.1 t/ha in "Tashkentsky 122" and "Kiva" varieties.

When sesame seeds were sown on July 10, the seeds fully germinated in 4 days and the plants entered the flowering stage in August. The crop had to be harvested on October 20 before physiological ripening. For forced germination of sesame seeds (in order to improve wind circulation during the drying period), the plants of each plot were tied together and left in the open field.

When the seeds were sown on July 10, the average yield was almost the same for all varieties, including "Black Shahzoda", "Tashkentsky 122" and "Kiva" was 1.4 t/ha, while "Urganch" averaged 1.45 t/ha was harvested. Based on the results of the conducted research, it was determined that June 10 is the optimal planting date for regionalized and new promising varieties of sesame.

When determining the effect of sowing dates on the productivity of the "Black Prince" sesame variety, the highest indicator was observed in the variant planted on May 10. Total expenses (preparation of land for washing, washing, fertilizers, fertilizing, mowing, cultivation, weeding, fight against diseases and insects, harvesting by hand, cleaning) and 24% additional expenses amounted to 10,540 thousand UZS, while the net profit on April 30 it was 29,860 thousand UZS when planted, 32,060 thousand UZS on May 10, 25,660 thousand UZS on April 20 , and 21,660 thousand UZS on May 30. The highest level of profitability was observed in the first ten days of May and equaled 304% (Table 3).

Table 3. Effect of the next planting dates on the economic efficiency of the "Black Prince" sesame variety.

Indicators	Unit of measure	Apr 30	May 10	May 20	May 30
Total cost, ha	'000 UZS	10540	10540	10540	10540
Productivity, q/ha	'000 UZS	20.2	21.3	18.1	16.1
Selling price of the product, kg	'000 UZS	20.0	20.0	20.0	20.0
Gross profit	'000 UZS	40400.0	42600.0	36200.0	32200.0
Cost of the product	'000 UZS	4,207	3.99	4.70	5.28
24% overhead	'000 UZS	2,040	2,040	2,040	2,040
Net profit	'000 UZS	29860.0	32060.0	25660	21660
Rate of return	%	283	304	243	205

In general, when sesame is grown as the main crop, the net income per hectare is 21,660-32,060 thousand UZS. The economic efficiency of growing sesame in repeated periods in the climatic conditions of Khorezm region was calculated and it was scientifically proven that sowing sesame seeds after June 20 is ineffective (Table 4).

Table 4. Effect of replanting periods on economic efficiency of the cultivar "Black Prince".

Indicators	Unit of measure	Jun 10	Jun 20	Jul 1	Jul 10
Total cost, ha	'000 UZS	10540	10540	10540	10540
Productivity, q/ha	'000 UZS	8.5	5.2	3.4	1.4
Selling price of the product, kg	'000 UZS	20.0	20.0	20.0	20.0
Gross profit	'000 UZS	17000	10400	6800	2800
The cost of the product	'000 UZS	12.4	20.3	31.0	75.0
Net profit	'000 UZS	6460.0	-140	-3740	-7740
Rate of return	%	61	-1	-35	-73

4 Conclusions and recommendations

Based on the specific climatic attributes of the Khorezm region, it is advisable to initiate sesame seed sowing within the initial and subsequent ten days of May. This particular timing is strategically chosen to foster the cultivation of a robust and superior sesame harvest during the spring season. By adhering to this recommended sowing window, agricultural practitioners in the Khorezm region can harness the optimal environmental conditions, thereby increasing the likelihood of yielding a high-quality and abundant sesame crop.

In the context of the Khorezm region's climatic conditions, it is advised to exercise caution and avoid postponing sesame seed sowing beyond June 15, especially when cultivating sesame as a subsequent or repeated crop. This recommendation is underpinned by the region's specific environmental dynamics and serves as a strategic measure to ensure optimal growth and yield outcomes for sesame crops. By adhering to this timeline, agricultural practitioners can effectively mitigate potential challenges associated with adverse weather patterns and other factors that could impede successful sesame cultivation as a repeated crop.

References

1. M.E. Amanova.//Biological characteristics of sesame ecogroups and primary sources for selection//Journal of Agro-science No. 1(21), 31 p. Tashkent 2012.
2. M.E. Amanova, A.S. Rustamov //Methodological manual for studying the world collection of oilseeds// "BIOEKOSAN" educational and methodological complex of the youth of the republic. Tashkent 2010. 20 pages, number 300.
3. Dospekhov B.A. Methodology polevogo opyta. - M.: Kolos, 2015-416 p.
4. N.I.Bochkaryov, S.G.Borodin//Rekomendatsii po semenovodstvu maslichnyx kultur i efiromaslichnyx kultur// Krasnodar. 2004
5. Ya.V. Gubanov //Technicheskie kultury//Moscow. Agropromizdat 2006.
6. MEAmanova, ASRustamov //Sesame new rare sources for selection from world collection//. Proceedings of the Uzbek-Japanese symposium on ecotechnologies. Tashkent-2016.
7. M.E. Amanova, A.S. Rustamov, L.R. Allanazarova //Recommendation on agrotechnics of sesame seeding and cultivation//. Tashkent 2018
8. Boboev, S., Makhkamov, T., Bussmann, R. W., Zafar, M., & Yuldashev, A. (2023). Anatomical and phytochemical studies and ethnomedicinal uses of Colchicum autumnale L. Ethnobotany Research and Applications, 25, 1-9. DOI:10.32859/era.25.6.1-9
9. TKh, M., Brundu, G., Jabborov, A. M., & Gaziev, A. D. (2023). Predicting the potential distribution of Ranunculus sardous (Ranunculaceae), a new alien species in the flora of Uzbekistan and Central Asia. BioInvasions Records, 12(1), 63-77. DOI:10.3391/bir.2023.12.1.05
10. Ameen, M., Zafar, M., Ahmad, M., Ramadan, M. F., Eid, H. F., Makhkamov, T., ... & Majeed, S. (2023). Assessing the Bioenergy Potential of Novel Non-Edible Biomass Resources via Ultrastructural Analysis of Seed Sculpturing Using Microscopic Imaging Visualization. Agronomy, 13(3), 735. DOI:10.3390/agronomy13030735
11. Noor, W., Zafar, M., Ahmad, M., Althobaiti, A. T., Ramadan, M. F., Makhkamov, T., ... & Khan, A. (2023). Petiole micromorphology in Brassicaceous taxa and its potential for accurate taxonomic identification. Flora, 303, 152280. DOI:10.1016/j.flora.2023.152280
12. Aziz, A., Ahmad, M., Zafar, M., Gaafar, A. R. Z., Hodhod, M. S., Sultana, S., ... & Chaudhay, B. (2023). Novel Copper Oxide Phyto-Nanocatalyst Utilized for the Synthesis of Sustainable Biodiesel from Citrullus colocynthis Seed Oil. Processes, 11(6), 1857. DOI:10.3390/pr11061857