E3S Web of Conferences **563**, 03013 (2024) https://doi.org/10.1051/e3sconf/202456303013
ICESTE 2024

Efficiency of seed production in growing sesame variety in the southern region of Uzbekistan

Kasimbek Isabaev[1*], *Oftoboyim* Kurbonova[2], *Sanoatkhon* Zakirova[3,1], *Khusnidakhon* Abdukhakimova[3,1], *Guzalkhon* Sotiboldieva[3,1]

[1]"TIIAME" National Research University, Tashkent 100000, Uzbekistan
[2]Karshi Engineering Economics Institute, Karshi 170090, Uzbekistan
[3]Fergana State University, Fergana 140010, Uzbekistan

Abstract. In this article, various cultivation periods and standards for the "Tashkent-122" variety of sesame were examined in the conditions of historically irrigated, moderately loamy, and slightly saline sandy loam soils in the Kashkadarya region. Compared to the control, the variations resulted in a reduction in soil bulk density by 0.02–0.03 g/cm^3, an increase in soil fertility by 0.2–0.4%, and a decrease in soil moisture retention to 23.8–23.6 m^3/ha. When sown with 2.0 million seeds per hectare on May 15th, preceded by irrigation (HCSPP), soil moisture remained at 65-65-60% relative to field capacity. Additionally, mineral fertilizers were applied at a rate of $N_{100}P_{80}K_{60}$ kg/ha, and seasonal irrigation totaled 1250 m^3/ha. This resulted in a sesame yield of 12.3 quintals per hectare, or an additional 2.1 quintals per hectare compared to the control. When sown on June 15th, with the same variety and seed rate, soil moisture was maintained at 75-75-60% relative to field capacity, with the same application of mineral fertilizers ($N_{100}P_{80}K_{60}$) and seasonal irrigation (HCSPP). This led to a sesame yield of 8.7 quintals per hectare, or an additional 2.3 quintals per hectare compared to the control. Each hectare yielded a net profit of 578,200 UZS, achieving a profitability level exceeding 28.3 percents.

1. Introduction

Today, globally, sesame is cultivated over an expansive area exceeding 6.7 million hectares, with an average yield of 3.9 quintals per hectare, leading to a total output of 2.9 million tons. Among the world's top sesame-producing countries, Myanmar (Burma) achieves yields of 4.9 quintals per hectare, India 3.4, China 10.2, Burkina Faso 7.2, Nigeria 5.0, and Somalia 9.4 quintals per hectare, with the highest yields observed in China [1]. To meet the nutritional demands of the Earth's growing population, along with the need for expanded irrigation and an increased demand for food products and vegetable oil, it is crucial to cultivate sesame and achieve both high and high-quality yields [2].

With the aim of enhancing the yield of global agricultural crops and ensuring a sufficient food supply for the population, as well as obtaining cost-effective, high-quality sesame yields while maintaining and improving soil fertility, attention is directed towards planting norms, schedules, and seedling thickness [3]. Specifically, through the proper selection of planting norms and care schedules for sesame, the population's demand for vegetable oil can be met, resulting in the cultivation of a high-quality crop. Recognizing this, it is pertinent to refine the elements of sesame cultivation agronomy and implement this technology widely based on scientific principles [4].

Several studies have delved into various factors including soil-physical properties, nutrient management, plant growth, productivity, and quality [5-7]. Despite these efforts, there remains a notable focus on training specialists in sesame breeding, cultivation techniques, nurturing practices, and processing methods [8].

However, in regions such as Kashkadarya, where saline soils require irrigation, there has been a lack of comprehensive scientific research on the selection and improvement of sesame varieties like "Tashkent-122", as well as the advancement of cultivation agrotechnology [9].

The aim of the study is to scientifically examine the impact of soil-physical and agrochemical properties, as well as its fertility, development, and productivity, on the cultivation duration and quality standards of the "Tashkent-122" variety of sesame in the conditions of light gray-earth soils to be irrigated in the Kashkadarya region of Uzbekistan.

*Corresponding author: k.isabaev@tiiame.uz

2. Materials and Methods

Field experiments were meticulously carried out, adhering closely to the procedures outlined in "Methods of Conducting Field Experiments." These procedures ensured that the experiments were conducted with precision and accuracy, allowing for reliable data collection and analysis [10].

The analyses to determine the quantity of nutrients in the soil and crops were conducted following the comprehensive guidelines provided in "Methods of Agrochemical and Agrophysical Research in Irrigated Cotton-growing Regions." These guidelines are specifically tailored to the conditions of irrigated cotton-growing regions, ensuring that the analyses are relevant and accurate for the specific agricultural context [2, 4].

In analyzing the data on sesame yield, sophisticated statistical methods were employed using Microsoft Excel software. This software facilitated the organization, visualization, and interpretation of the data, allowing for detailed insights into the factors influencing sesame yield. The statistical analysis was conducted in accordance with the principles outlined in B.A. Dospekhov's "Field Experiment Methodology," a renowned resource in the field of agricultural research [7, 8]. This methodology ensured that the statistical analysis was robust and reliable, providing meaningful results that could be used to inform agricultural practices and decision-making.

3. Results and Discussion

Field experiments were conducted from 2018 to 2020 in the "Jasurbek Pulatovich" farm located in the Nishon district of the Kashkadarya region, focusing on sesame cultivation using the "Tashkent-122" variety in light gray-earth soils. The experiments were repeated three times, with each plot covering an area of 240 square meters, of which 120 square meters were utilized for actual experimentation, constituting a total area of 1.2 hectares.

The soil of the experimental plot in the cultivation area had a humus content of 0.979%, total nitrogen of 0.098%, and total phosphorus of 0.271%. Additionally, the available nitrogen content was determined to be 20.7 mg/kg, phosphorus 33.8 mg/kg, and potassium content 148.0 mg/kg. According to classification, it was found that the soil was deficient in nitrogen, moderate in phosphorus, and deficient in potassium.

Based on the data from the 2018 experiment, at the beginning of the cultivation period, the soil in the 0-30 cm layer contained 0.979% humus, 0.098% nitrogen, and 0.271% phosphorus. When sesame was cultivated in all variants until the end of the growing season on May 15th, with a seeding rate of 1.5 million seeds per hectare or 5 kg/ha, the soil in the 0-30 cm layer exhibited a decrease in humus content to 0.958%, nitrogen to 0.088%, and phosphorus to 0.262%. The nitrate nitrogen content was 21.2 mg/kg, available phosphorus was 31.3 mg/kg, and exchangeable potassium was 142.4 mg/kg. When the seeding rate was increased to 2.0 million seeds per hectare or 6 kg/ha, the overall soil indicators were 0.963%, 0.092%, and 0.256% for humus, nitrogen, and phosphorus, respectively. The corresponding values for nitrate nitrogen, available phosphorus, and exchangeable potassium were 22.3 mg/kg, 32.5 mg/kg, and 143.2 mg/kg. Similarly, when the seeding rate was further increased to 2.5 million seeds per hectare or 7 kg/ha, and 3.0 million seeds per hectare or 8 kg/ha in the fourth variant, the overall soil indicators were 0.960%, 0.089%, and 0.251% for humus, nitrogen, and phosphorus, respectively. The respective values for nitrate nitrogen, available phosphorus, and exchangeable potassium were 20.6 mg/kg, 33.5 mg/kg, and 148.4 mg/kg in the third variant, and 20.5 mg/kg, 33.4 mg/kg, and 148.6 mg/kg in the fourth variant. It was observed that compared to the beginning of the cultivation period, there was a decrease in the content of all nutrients in the soil, although other indicators were higher in the cultivated plots.

In the research conducted regarding the influence of various planting densities and durations of sesame variety "Tashkent-122" on soil bulk density (2018), it was found that at the beginning of the growing season, the bulk density of the soil in the 0-30 cm layer was 1.33 g/cm^3, in the 0-50 cm layer it was 1.36 g/cm^3, and in the 0-100 cm layer it was 1.38 g/cm^3. By the end of the sesame growing season, on May 15th, when planted at a rate of 1.5 million seeds per hectare or 5 kg/ha (control), the bulk density of the soil in the 0-30 cm layer was determined to be 1.37 g/cm^3, in the 0-50 cm layer it was 1.39 g/cm^3, and in the 0-100 cm layer it was 1.46 g/cm^3, showing an increase of 0.02-0.03 g/cm^3 compared to the beginning of the growing season. Similarly, when sesame was planted on June 15th, these indicators were found to be 1.34, 1.37, and 1.46 g/cm^3 respectively, with an increase of 0.02-0.04 g/cm^3 compared to the beginning of the growing season. When sesame was cultivated with a seeding rate of 2.0 million seeds per hectare on May 15th, the bulk density of the soil in the 0-30 cm layer was 1.31 g/cm^3, in the 0-50 cm layer it was 1.35 g/cm^3, and in the 0-100 cm layer it was 1.42 g/cm^3, with an increase of up to 0.01 g/cm^3 compared to the beginning of the growing season, and when planted on June 15th, an increase of 0.01-0.03 g/cm^3 compared to the beginning of the growing season was determined.

When sesame was planted at rates of 2.5-3.0 million seeds per hectare, the bulk density of the soil in the 0-30 cm layer was found to be 1.32-1.34 g/cm^3, in the 0-50 cm layer it was 1.35-1.38 g/cm^3, and in the 0-100 cm layer it was 1.43-1.45 g/cm^3, showing an increase of 0.01-0.04 g/cm^3 compared to the beginning of the growing season. Similarly, when planted only on June 15th of the year, the increase compared to the beginning of the growing season was observed to be 0.02-0.06 g/cm^3. In our conducted research, it was observed that when sesame was planted at a rate of 2.0 million seeds per hectare, the bulk density of the soil decreased by 0.01-0.03 g/cm^3 compared to when planted at other rates (see Figure 1).

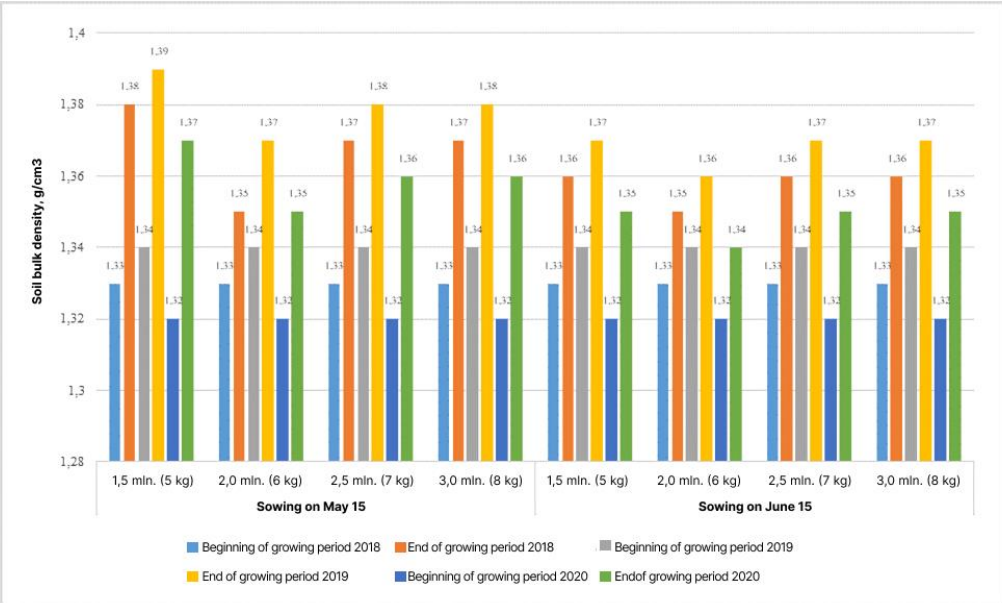

Fig. 1. Influence of sesame planting duration and rates on soil bulk density

In the 2018 experiment, soil fertility indicators showed a slight decrease in bulk density. For instance, in the field planted on May 15th, the soil fertility in the plowed layer (0-30 cm) was 51.9%, in the 0-50 cm layer it was 50.4%, and in the 0-100 cm layer it was 47.8%. When compared, the values in the field planted on June 15th were 51.5%, 50.0%, and 47.4%, respectively.

Upon reaching the end of the growth period of sesame, in the first variant where 1.5 million seeds/ha were planted, soil fertility in the plowed layer (0-30 cm) was 50.7%, in the 0-50 cm layer it was 49.6%, and in the 0-100 cm layer it was 46.7%. Relative to the beginning of the growth period, there was a decrease in soil fertility indicators by 0.8-1.2%. When the seeds were planted on June 15th, the corresponding indicators for the fields were 50.4%, 49.3%, and 45.9%, respectively, showing a decrease by 0.7-1.5% relative to the beginning of the growth period.

When sesame was sown at a rate of 2.5 million seeds/ha on May 15th in the third variant, soil fertility in the plowed layer (0-30 cm) was 51.1%, in the 0-50 cm layer it was 50.0%, and in the 0-100 cm layer it was 47.0%. Relative to the beginning of the growth period, there was a decrease of 0.4-0.8% in these values. After planting on June 15th, the corresponding indicators were 50.7%, 49.3%, and 45.9%, respectively, showing a decrease by 0.7-1.5% relative to the beginning of the growth period.

When sesame was sown at a rate of 3.0 million seeds/ha on May 15th in the fourth variant, soil fertility in the plowed layer (0-30 cm) was 50.4%, in the 0-50 cm layer it was 48.9%, and in the 0-100 cm layer it was 46.3%. Relative to the beginning of the growth period, there was an increase of 1.5% in these values. After planting on June 15th, the corresponding indicators were 50.0%, 48.1%, and 45.2%, respectively, indicating an increase by 1.5-1.9% relative to the beginning of the growth period. (Table 1).

Table 1. Impact of various sesame cultivation periods and methods on soil fertility, % (2018)

Soil layers, cm	**In the beginning of growth period**	**In the end of growth period**			
		Variant 1	**Variant 2**	**Variant 3**	**Variant 4**
		The field where sesame was planted on May 15th			
0-30	51.9	50.7	51.5	51.1	50.4
0-50	50.4	49.6	50.0	50.0	48.9
0-100	47.8	46.7	47.4	47.0	46.3
		The field where sesame was planted on June 15th			
0-30	51.5	50.4	51.1	50.7	50.0
0-50	50.0	49.3	49.3	49.3	48.1
0-100	47.4	45.9	46.3	45.9	45.2

In studies conducted (2018) on soil's agronomic aspects, in the field where sesame seeds were sown on May 15th, the soil's favorable fractions in terms of agronomy (<10->0.25 mm) constituted 71.6% in the top 30 cm layer, 71.2% in the top 50 cm layer, and 70.4% in the top 100 cm layer at the beginning of the growth period. However, when the planting was scheduled for June 15th, it was observed that in the field with adjusted planting, the soil's favorable fractions were 70.5% in the top 30 cm layer, 69.4% in the top 50 cm layer, and 69.0% in the top 100 cm layer.

By the end of sesame's growth period, when the seeds were sown on May 15th at a rate of 1.5 million seeds per hectare, the quantity of the soil's agronomically favorable fractions compared to the beginning of the growth period decreased by 0.8-1.2% in the case of planting on June 15th, this decrease ranged from 0.5-1.5%.

When the sesame cultivation was 2.0 million seeds per hectare on May 15th, the quantity of the soil's agronomically favorable fractions decreased by 0.1-0.4% compared to the beginning of the growth period, and when cultivation was on June 15th, this decrease ranged from 0.4-0.6%.

However, in other planting standards in the experimental field, it was noted that the percentage of soil's favorable fractions in the top 30 cm layer was 0.5-1.6% higher compared to planting sesame, indicating higher levels, as shown in Figure 2.

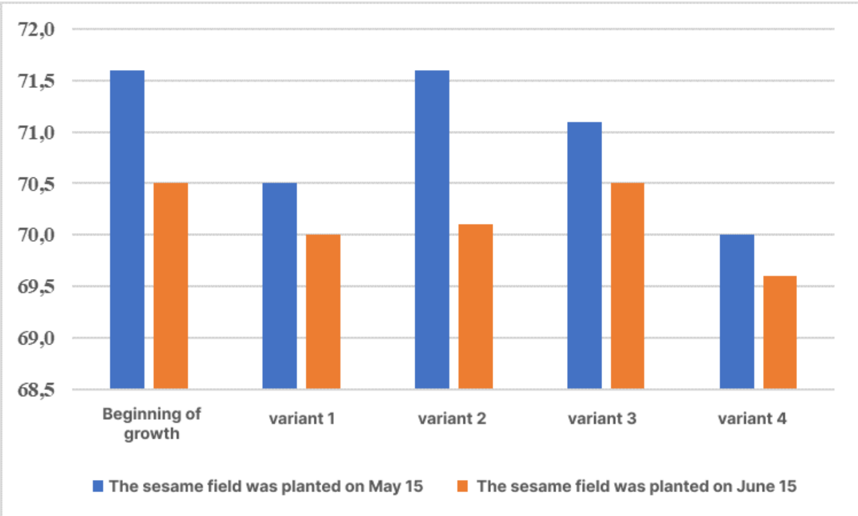

Fig. 2. Influence of sesame planting duration and conditions on the quantity of soil agronomic fractions, %

In the experiments conducted, the total water permeability of the initial soil in the experimental field was 927.9 m^3/ha in 6 hours. By the end of the sesame growing season, it was observed that in all variants, there was a slight decrease in this indicator due to the implemented agronomic measures. When sesame was planted on May 15th at a rate of 2.0 million seeds/ha and grown, it was found that the total water permeability in 6 hours was higher by 1.2-100.0 m^3/ha compared to planting under different conditions. For sesame fields planted on June 15th, the total water permeability of the initial soil was determined to be 928.1 m^3/ha. At a seeding rate of 1.5 million seeds/ha, the total water permeability in 6 hours was 825.4 m^3/ha, while for seeding rates of 2.0 million seeds/ha, 2.5 million seeds/ha, and 3.0 million seeds/ha, it was 910.7 m^3/ha, 810.7 m^3/ha, and 909.5 m^3/ha, respectively (Figure 3). According to the classification by S.V. Nesterov, it was noted that the entry of soil into the system of poorly permeable soils occurred in the field where the research was conducted.

The rate and amount of sesame irrigation depend on the type and density of crops, as well as on climatic, hydrogeological, and soil-improving conditions, as determined by S.N. Ryzhov's method using a formula:

$$m = (W_{HCSPP} - W_{CAF})100\,Jh + k \text{, m}^3\text{/ha}$$

where: W_{hcspp}- refers to the weighted harmonic mean of soil depth calculated as a percentage of soil density; W_{caf}- refers to calculating the effective porosity of soil as a percentage of soil density; J- Soil bulk density, g/cm^3; h - calculated layer, m; k - water consumption during irrigation, m^3/ha (increased by 10% due to the non-uniformity of moisture content in the calculated layer).

In the field where 2 million seeds of sesame were sown on May 15, when irrigation was carried out in proportions of 65-65-60% relative to the HCSPP (Hydraulic Calculation of Simple Pressure Pipelines), the seasonal irrigation rate amounted to 1950 m^3/ha. On June 15, when irrigation was carried out in proportions of 75-75-60% relative to the HCSPP, the seasonal irrigation rate amounted to 1850 m^3/ha.

 https://doi.org/10.1051/e3sconf/202456303013

Considering the soil moisture, water for irrigation, and atmospheric humidity, the water consumption for irrigation was determined. When 2 million seeds were sown on May 15, and irrigation was carried out in proportions of 65-65-60% relative to the HCSPP, the water consumption per hundredweight of sesame produced was 98.5 m³/cwt. When sown on June 15, and irrigation was carried out in proportions of 75-75-60% relative to the HCSPP, the water consumption per hundredweight of sesame produced was 87.9 m³/cwt.

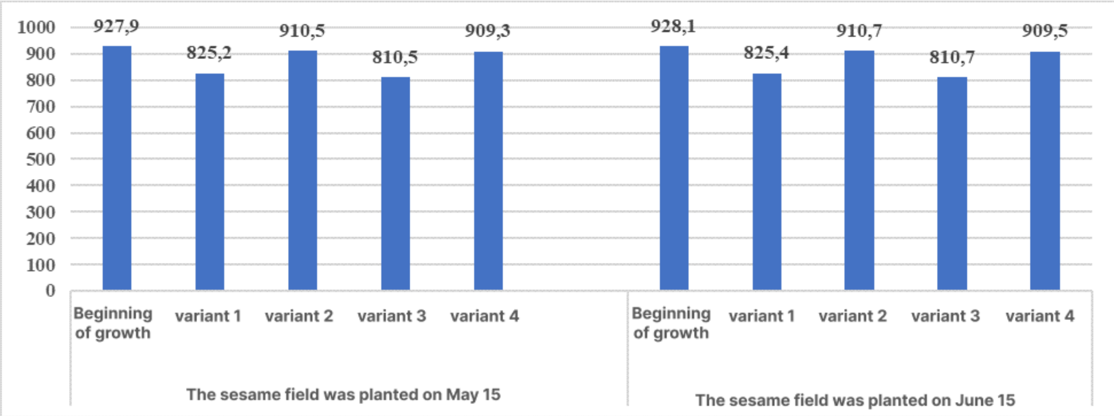

Fig. 3. Influence of sesame planting duration and parameters on the soil water permeability level, m³/ha (2018)

In phenological observations conducted in 2018 to determine the biometric indicators of sesame, when sown on May 15 at a rate of 1.5 million seeds per hectare or 5 kg/ha, the height of the plants reached 135 cm, with 5 branches per plant, and the average weight of 1000 seeds was 2.1 grams. When the seeds were sown at a rate of 2.0 million seeds per hectare or 6 kg/ha, these indicators were observed to be 142 cm, 7 branches, and 2.5 grams, respectively. Similarly, when sown at a rate of 2.5 million seeds per hectare or 7 kg/ha, the indicators were 138 cm, 5 branches, and 2.4 grams. When sown at a rate of 3.0 million seeds per hectare or 8 kg/ha, the indicators were 140 cm, 5 branches, and 2.3 grams per 1000 seeds, respectively.

When sesame seeds were sown on June 15 at a rate of 1.5 million seeds per hectare or 5 kg/ha, the height of the plants reached 80 cm, with 3 branches per plant, and the average weight of 1000 seeds was 1.7 grams. In the remaining fields where the same sowing rates were utilized, the indicators were observed to be consistent, with heights of 90 cm, 4 branches, and 1.9 grams; 85 cm, 3 branches, and 1.8 grams; and 82 cm, 4 branches, and 1.8 grams per 1000 seeds, respectively.

Table 2. Effect of different planting durations and densities on sesame cultivation yield

#	Variations	Yearly yield, quintals per hectare			Average yield, quintals per hectare
		2018	2019	2020	
	The field planted with sesame on May 15th				
1	1.5 mln. (5 kg)	8.5	10.2	12.5	10.2
2	2.0 mln. (6 kg)	10.2	12.3	14.4	12.3
3	2.5 mln. (7 kg)	8.4	9.8	12.1	10.2
4	3.0 mln. (8 kg)	8.5	9.9	12.4	10.3
	The field planted with sesame on June 15th				
1	1.5 mln. (5 kg)	5.5	5.6	5.4	5.2
2	2.0 mln. (6 kg)	8.5	8.4	8.8	8.7
3	2.5 mln. (7 kg)	5.8	5.9	6.0	5.9
4	3.0 mln. (8 kg)	5.8	5.4	5.9	5.6
	EKF_{05}=	0.25 quintals	0.38 quintals	0.33 quintals	
	EKF_{05}=	3.2 %	4.7 %	4.1 %	

According to the research results obtained from the cultivation of the "Tashkent-122" variety of sesame, the highest yield was achieved when sown on May 15 at a rate of 2.0 million seeds per hectare or 6 kg/ha. In this scenario, an average yield of 12.3 quintals per hectare was obtained over three years, with an additional yield of 2.1 quintals per hectare compared to the control group.

When the "Tashkent-122" variety of sesame was cultivated on June 15 at a rate of 2.0 million seeds per hectare or 6 kg/ha, a yield of 8.7 quintals per hectare was obtained. This represents an additional yield of 2.5 quintals per hectare compared to the control group (Table 2).
When considering the economic efficiency, it became apparent that in the conditions of moderately saline soils, the "Tashkent-122" variety of sesame showed the highest performance when sown with 2.0 million seeds per hectare or at a rate of 6 kg/ha on May 15th, yielding a net profit of 1,954,600 UZS or achieving a profitability of 38.7%. Conversely, the lowest performance was observed when sowing with 3.0 million seeds per hectare or at a rate of 8 kg/ha, resulting in a net profit of 677,600 UZS or a profitability of 13.0%, representing a decrease in net profit by 1,277,000 UZS and 25.7% compared to the first variant.
For sesame sown on June 15th with 2.0 million seeds per hectare or at a rate of 6 kg/ha, the net profit amounted to 541,580,000 UZS, resulting in a profitability of 28.3%. In contrast, the least favorable results were obtained when sowing with 3.0 million seeds per hectare or at a rate of 8 kg/ha, yielding a net profit of 501,454,000 UZS or a profitability of 10.2%, indicating a decrease in net profit by 40,126 UZS and 18.1% compared to the second variant.

4. Conclusions

To ensure consistent and high-quality sesame yields in the conditions of anciently irrigated, moderately saline sandy loam soils of the Kashkadarya region, the following recommendations are proposed for the cultivation of the "Tashkent-122" variety:
1. Sow sesame "Tashkent-122" with 2.0 million seeds per hectare on May 15th, irrigating the fields to maintain soil moisture at 65-65-60% relative to field capacity.
2. Apply mineral fertilizers at a rate of nitrogen-100, phosphorus-80, and potassium-60 kg/ha.
3. For irrigation during sesame cultivation, maintain soil moisture at 65-65-60% relative to field capacity, recommending an irrigation volume of 900-1050 m^3 per irrigation, and a seasonal irrigation amount ranging from 1950 to 1850 m^3/ha.

References

1. Namozov K, Korakhonova Y, Khojasov M, Isaev S, Khojasov A, Change in agrophysical properties of the soils of the lower Amu Darya river terrain, *IOP Conference Series: Earth and Environmental Science* **1112**(1), 012128 (2022)
2. Isayev S, Malikov E, Tadjiev S, Berdiyorov E, Pulatova M, Modelling effects of irrigation with collector-drainage water on second crop productivity in sample of mung beans, *E3S Web of Conferences* **365**, 01021 (2023)
3. Isaev S, Khasanova O, Boltaev S, Dauletbayev B, Djumanazarova A, Efficiency of drip irrigation of almonds and pistachios with snow and rainwater, *E3S Web of Conferences* **371**, 01044 (2023)
4. Isaev S, Tadjiev S, Ibragimov O, Zokirova S, Khojasov A, Improving cotton irrigation methods in erodible soils of Tashkent province Uzbekistan, *E3S Web of conferences* **371**, 01005 (2023)
5. Isaev S, Bekmirzaev G, Usmanov M, Malikov E, Tadjiev S, Butayarov A, Provision of remote methods for estimating soil salinity on meliorated lands, *E3S Web of Conferences* **376**, 02014 (2023)
6. Bekmirzaev G, Beltrao J, Isaev S, Usmanov M, Tadjiev S, Zakirova S, Isagaliev M, Use of halophyte plants on saline soils and evaluation of salt removal efficiency, *E3S Web of Conferences* **389**, 03043 (2023)
7. Isaev S, Sarimsakov M, Sarimsakova M, Turdaliev A, Abdukhakimova K, Mirzaeva M, Application of water-saving irrigation technologies of intensive apple orchards in the irrigated regions of Uzbekistan, *E3S Web of Conferences* **389**, 03052 (2023)
8. Isaev S, Gofirov A, Tadjiyev S, Bulanbayeva P, Djumanazarova A, Effects of different salinity levels in topsoil on the growth development and yield of winter wheat, *BIO Web of Conferences* **65**, 04004 (2023)
9. Bazarov D, Markova I, Norkulov B, Isabaev K, Sapaeva M, Operational efficiency of water damless intake, *IOP Conference Series: Materials Science and Engineering* **869**(7), 072051 (2020)
10. Uralov B, Isabaev K, Jamolov F, Akhmadi M, Mirzaev M, The influence of the shape the living section of the pressureless machine channel and the roughness of its wetted surface on the hydraulic resistance, *IOP Conference Series: Materials Science and Engineering* **883**(1), 012006 (2020)