

AGROTECHNOLOGY AND ECONOMIC EFFICIENCY OF CULTIVATING BLACK CUMIN (NIGELLA SATIVA L.) IN SALINE SOILS

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Abstract

The effective cultivation of black cumin (*Nigella sativa* L.) under saline soil conditions requires the scientifically based implementation of agro-technical measures. Achieving high crop productivity is associated with timely and proper execution of pre-sowing soil preparation, sowing operations, crop management during the vegetation period, and harvesting activities. This article presents data on the agro-technological practices and economic efficiency of cultivating *Nigella sativa* L. in the soils of the Tashkent region.

Keywords: Black cumin (*Nigella sativa* L.), soil, efficiency, seed, yield, income, cost.

Introduction

Soil management in these areas differs from that in non-saline lands. After harvesting crops, soil leaching is carried out in autumn. Each hectare is irrigated twice with 3,000 m³ of water. Soil leaching is performed without autumn ploughing. During leaching, proper functioning of drainage systems around the fields is ensured to remove dissolved salts from the soil.

As a result of intensive irrigation during leaching, soil particles become compacted, pore space decreases, and air is expelled, leading to soil densification. Therefore, such lands are ploughed in spring before sowing. The main task during the pre-sowing period is to enrich the soil with nutrients and prepare it for planting. It is recommended to apply 40 t/ha of cattle manure.

To improve the efficiency of organic fertilizers, manure is composted in piles. Every 20–25 cm layer of manure is treated with 19% superphosphate and stacked. The compost heap is formed with a width of 1.3–2.0 m and a height of 1.0–1.3 m, and covered with a 10–15 cm soil layer. Approximately 420 kg of superphosphate is added to 40 tons of manure.

Mineral fertilizers are also applied to increase soil fertility. In this case, 420 kg/ha of superphosphate, 350 kg/ha of ammophos, and 80 kg/ha of potassium salt are applied using fertilizer spreaders. Subsequently, the land is ploughed using a TTZ-812 tractor and a PN-4-30 plough. After ploughing, harrowing and leveling are carried out to improve soil structure and create optimal conditions for sowing.



Black cumin seeds are sown in the second ten-day period of April. Prior to sowing, field chiseling is performed in both directions to reduce weeds and loosen the soil, improving aeration. Then ridges with a row spacing of 45 cm are formed using a TTZ-812 tractor and ridge-forming equipment. Sowing is carried out using a BM-24 seed drill, with an in-row spacing of 15 cm. After sowing, irrigation channels are constructed. To ensure uniform germination, irrigation is applied at a rate of 900 m³/ha.

During the vegetation period, several agronomic practices are carried out. Irrigation channels are leveled and irrigation is performed multiple times, maintaining soil moisture at 60–70% of field capacity. Mechanical inter-row cultivation is carried out to control weeds and loosen soil, improving aeration and nutrient uptake. Preventive plant protection measures are also implemented using chemical preparations, ISO decoction, and 1% Bordeaux mixture. Biological control against pests is ensured through the use of green lacewing (*Chrysoperla carnea*) entomophages.

Black cumin seeds usually ripen in the second half of July. Harvesting is carried out under dry weather conditions to minimize seed loss and maintain product quality.

Based on research results, the economic efficiency of cultivating *Nigella sativa* L. was analyzed using data from Yangiyul district farms.

The economic indicators show how production costs and profitability were formed over the years under different influencing factors. Initially, land preparation costs increased from 3,350 thousand UZS in 2023 to 4,180 thousand UZS in 2025, an increase of 830 thousand UZS. This growth is mainly attributed to rising fuel prices, increased machinery use, and higher labor costs.

Seed procurement and sowing costs also showed a gradual increase. Seed costs increased by 190 thousand UZS, while sowing labor costs increased by 60 thousand UZS due to rising wage rates. Water usage costs demonstrated a significant increase, rising from 9,516 thousand UZS in 2023 to 22,955.5 thousand UZS in 2025. This sharp increase is associated with water scarcity, higher electricity and pumping costs, and increased irrigation frequency. Thus, water is identified as the most significant cost-driving factor in black cumin production.

Fertilizer costs also increased, reaching 22,692.7 thousand UZS in 2025. In particular, organic manure costs increased by 2,365 thousand UZS, reflecting intensified soil fertility management practices. Mineral fertilizer use also increased gradually to maintain soil productivity and improve yield quality.

Crop protection costs increased to 1,995 thousand UZS, indicating intensified disease and pest control measures aimed at reducing yield losses. Harvesting and storage costs also increased due to higher production volumes and improved storage requirements. Overall production costs rose from 38,751 thousand UZS in 2023 to 57,036.8 thousand UZS in 2025.

Despite increased costs, production outcomes improved. Total yield increased from 1.98 tons to 2.28 tons, while the market price of 1 kg of black cumin rose from 54,000 to 70,000 UZS. As a result, revenue and gross profit increased significantly, and profitability reached 179.8% in 2025. Further analysis confirms that, despite rising production costs, improved yield and higher market prices ensured strong economic efficiency. The results indicate that rational use of water, fertilizers, and labor resources can further enhance profitability in black cumin cultivation.

A second dataset also confirms similar trends at a smaller scale, where total costs increased from 2,054.5 thousand UZS in 2023 to 3,007.4 thousand UZS in 2025. Yield increased from 102 kg to

118 kg, while profitability improved to 174.7%.

Overall, the cultivation of *Nigella sativa* L. in experimental farms proves to be economically efficient, and optimization of irrigation and agronomic practices offers further potential for increasing profitability.

Table 1 Economic efficiency indicators of black cumin (*Nigella sativa* L.) cultivation (2023–2025) (calculated per 1.90 ha / thousand UZS basis)

No.	Indicators	2023	2024	2025	Change in 2025 compared to 2023
1	Land preparation	3350	3728	4180	830.0
1.1	Fuel and labor costs for ploughing	1210	1246	1425	215.0
1.2	Fuel and labor costs for chiseling and harrowing	530	590	665	135.0
1.3	Fuel and labor costs for harrowing	530	590	665	135.0
1.4	Fuel and labor costs for leveling	530	590	665	135.0
1.5	Fuel and labor costs for furrow formation	550	712	760	210.0
2	Seed purchase costs (19 kg)	1520	1615	1710	190.0
3	Labor costs for sowing seeds (19 kg)	700	720	760	60.0
4	Water resources	9516.0	17568.0	22955.5	13439.5
4.1	Irrigation water usage (1220 × 6 = 7320 m ³)	9516.0	17568.0	22955.5	13439.5
5	Fertilization	19845.0	19457.0	22692.7	2847.7
5.1	353.4 kg nitrogen (nitrate) costs	600	650	706.8	106.8
5.2	110.2 kg phosphorus costs	680	710	771.4	91.4
5.3	62.7 kg sulfur costs	150	177	219.45	69.5
5.4	85.5 tons manure costs	17300	16650	19665	2365.0
5.5	Labor costs for fertilizer application	1115	1270	1330	215.0
6	Crop care	1620	1780	1995	375.0
6.1	Cultivation and plant protection costs (diseases and pests)	1620	1780	1995	375.0
7	Harvesting labor costs (seed collection)	2000	2260	2470	470.0
8	Storage costs (hemp sacks)	200	210	273.6	73.6
9	Total costs	38751.0	47338.0	57036.8	18285.8
10	Total yield (tons)	1.98	2.17	2.28	0.3
11	Price of 1 kg black cumin seed (thousand UZS)	54	60	70	16.0
12	Revenue from product sales (thousand UZS)	106920	130200	159600	52680.0
13	Gross profit (thousand UZS)	68169	82862	102563.2	34394.2
14	Profitability (%)	175.9	175.0	179.8	3.9



Table 2 Economic efficiency indicators of black cumin (*Nigella sativa* L.) cultivation (2023–2025) (calculated per 0.1 ha / thousand UZS basis)

No.	Indicators	2023	2024	2025	Change (2025 vs 2023)
1	Land preparation	156	166	189	33.0
1.1	Fuel and labor costs for ploughing	56	58	62	6.0
1.2	Fuel and labor costs for chiseling and harrowing	24	26	31	7.0
1.3	Fuel and labor costs for harrowing	24	26	31	7.0
1.4	Fuel and labor costs for leveling	24	26	31	7.0
1.5	Fuel and labor costs for furrow formation	28	30	34	6.0
2	Seed purchase costs (1 kg)	82	85	90	8.0
3	Sowing labor costs (1 kg)	36	38	40	4.0
4	Water resources	500.5	924.0	1207.4	706.9
4.1	Irrigation water use (64 × 6 = 385 m ³)	500.5	924.0	1207.4	706.9
5	Fertilization	1042.0	1076.0	1218.0	176.0
5.1	18.6 kg nitrogen (nitrate) costs	35	36	42	7.0
5.2	5.8 kg phosphorus costs	36	37	42	6.0
5.3	3.3 kg potassium chloride costs	9	10	13	4.0
5.4	400 kg biocompost (Biogumus) costs	480	490	590	110.0
5.5	50 liters bioturf costs	420	440	460	40.0
5.6	Fertilizer application labor costs	62	63	71	9.0
6	Crop care	105	110	115	10.0
6.1	Cultivation and plant protection (diseases and pests)	105	110	115	10.0
7	Harvesting labor costs (seed collection)	118	125	130	12.0
8	Storage costs (hemp sacks)	15	17	18	3.0
9	Total costs	2054.5	2541.0	3007.4	952.9
10	Total yield (kg)	102.0	120.0	118.0	16.0
11	Price of 1 kg black cumin seed (thousand UZS)	55	60	70	15.0
12	Revenue from product sales (thousand UZS)	5610	7200	8260	2650.0
13	Gross profit (thousand UZS)	3555.5	4659	5252.64	1697.1
14	Profitability (%)	173.1	183.4	174.7	1.6

Comparative Analysis and Discussion

The comparative analysis based on the data presented in Tables 1 and 2 enables the identification of key factors influencing the economic efficiency of cultivating black cumin (*Nigella sativa* L.) in different regions of the Republic of Karakalpakstan. In particular, the cost structure, production volume, and financial outcomes were comparatively analyzed based on experimental farm data from Yangiyul district.

First, it should be noted that differences in production scale and accounting units significantly affect absolute values. In the Kegeyli district, indicators were calculated for a 1.90 ha area, whereas in the Samanbay experimental farm, calculations were conducted for a 0.1 ha area. Therefore, differences in absolute values are primarily explained by differences in land size. However, despite this, both farms demonstrate similar trends in cost dynamics and structural composition.

In this context, land preparation costs show a consistent upward trend over 2023-2025 in both cases. In Kegeyli district, these costs increased by 830 thousand UZS, while in Samanbay they increased by 33 thousand UZS. Although the absolute values differ significantly, the growth pattern is largely driven by rising fuel prices and increasing labor costs, which represent common economic factors across both locations.

A similar trend is observed in seed-related expenses. In both farms, seed procurement and sowing



labor costs increased over time. These costs are relatively lower due to the smaller cultivated area, although their growth trend corresponds to market-driven price increases and demand for high-quality seed material.

Fertilization costs also represent an important comparative indicator. In Kegeyli district, emphasis was placed on organic manure and mineral fertilizers, whereas in the Samanbay experimental farm, biologically based fertilizers such as biocompost (biogumus) and bioturf were widely applied. As a result, fertilization costs increased in both farms; however, their structural composition differs, reflecting variations in agro-technological approaches.

Another similarity is observed in crop care and protection costs. In both farms, these expenses show a relatively stable and moderate increase, indicating consistent implementation of agronomic practices for black cumin cultivation. Harvesting and storage costs also increased in both cases, which is associated with higher yields and increased labor requirements.

Based on the above findings, the following conclusion can be proposed as an optimal recommendation for practical application:

- For research stations and farms with limited resources, the 2024 production scenario can be considered the most optimal, since:
 - a balanced combination of organic and mineral fertilizers was maintained;
 - overall production costs were relatively lower;
 - profitability reached its highest level;
 - production practices were aligned with environmental sustainability requirements.

Therefore, based on the above analytical findings, the selection of the most optimal production model must be scientifically justified. Although the same crop-black cumin (*Nigella sativa* L.)-was cultivated in both experimental systems, significant differences were observed in agro-technological approaches, fertilization systems, resource utilization efficiency, and economic outcomes. This allows for comparative evaluation and identification of the most efficient production model for practical implementation.

Conclusion

The integrated application of agro-technical measures ensures optimal development of black cumin. Under the conditions of the Tashkent region, sowing in the first ten days of April, row spacing of 45 cm, intra-row spacing of 15 cm, and irrigation management maintaining soil moisture at 60–70% of field capacity ensure high biometric indicators and seed yield of up to 828 kg/ha.

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