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Seed harvest from medicinal fennel, *Foeniculum vulgare* Mill, in desert areas

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ABSTRACT

In this study, the spread of the medicinal fennel, *Foeniculum vulgare* Mill, government decisions on propagation, as well as the development of optimal agricultural technologies for the cultivation of medicinal fennel were assessed. In addition, the research on the number of branches of fennel, the number of flowers and the length of the roots of the fertilizers used in the studies were conducted at the end of 2018. The norms of $N_{20}P_{60}K_{40}$, $N_{40}P_{60}K_{40}$ and $N_{60}P_{60}K_{40}$ were applied to obtain high quantity and quality seeds. The optimal amounts were determined and the information was cited.

Keywords: Medicinal plant, Fennel, Foeniculum vulgare, Soil-climate, Agrotechnology.
Article type: Research Article.

INTRODUCTION

Importance of the topic. It is known that more than half of the drugs produced in the world are prepared from raw materials of medicinal plants. In particular, 77% of medicinal preparations used in the treatment and prevention of cardiovascular diseases, 74% in the treatment of liver and gastrointestinal diseases, 73% of expectorant drugs, and 60% of hemostatic drugs are produced on the basis of raw materials of medicinal plants (Barrahi *et al.* 2020; Mheidi *et al.* 2023; Mikhaylov 2003). Nowadays, ultivation of medicinal plants, organization of special plantations and delivery of raw materials of environmentally friendly products, adapting medicinal plants to local conditions, studying their bioecological properties and developing methods of cultivation, establishing plantations, expanding the areas of endangered medicinal plants growing in medical conditions, and deepening scientific research on them are one of the main urgent issues facing the scientists in Uzbekistan. Based on these problems and today's demand, reforms in Uzbekistan are aimed at effective use of lands that have not been used for thousands of years and conducting scientific research. Accordingly, we conducted practical and innovative projects within the framework of state programs related to scientific activity, the establishment of plantations of medicinal plants, the introduction of arid, pest-resistant, disease-resistant desert plants within the framework of scientific-research works "Medicinal white cumin- *Foeniculum vulgare* Mill on the lands of the Forest Fund. Scientific research work was carried out on the development of advanced cultivation technologies of these medicinal plants and high seed yield in the foothills and desert areas of the Navoiy region as part of the theme "Development of advanced technologies that ensure high productivity of the plant in different soil and climate conditions". Fennel medicinal plant is important, since it contains a lot of essential oils and it is used a lot in medicine. Essential oils in medicine are taken orally as medicine or applied to the body, as well as injected. In addition, some drugs are parts of the mixture. Medicines made from plants containing essential oil are also widely

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used in medicine. Essential oils have long been used in pharmaceuticals to improve the taste and smell of other drugs. Since many essential oils have bactericidal properties, they are used in the treatment of dental diseases and inhalation (respiratory disinfection). Essential oils are also used to improve the air in rooms (often hospitals). These oils are mostly used in perfumery, cosmetics, technology and food industry. In addition, they usually consist of a mixture of volatile organic compounds with a specific smell and taste, which are extracted using water vapor. In the Middle Ages, the Arabs knew how to extract essential oil from plant raw materials using water vapor. To date, convenient and effective technologies for extracting essential oils have been developed, and the scientific research conducted in this direction is a continuation of these works (Medicinal Plant Cultivation and Processing Center 2018).

Plant propagation. The fennel plant, *Foeniculum vulgare* Mill grows naturally in Crimea, Caucasus steppes, and the southern part of Central Asia. It is cultivated in Ukraine, Krasnodar Territory of the North Caucasus and the Republic of Belarus. In Uzbekistan, under the irrigation conditions of Uzun and Kitab forestry farms, the height of the plant is 2 m, higher in the first year, and many blooming fruit harvests are grown. *F. vulgare* is a valuable medicinal plant with bitter aroma and essential oil, improves digestion, eyesight, kidney disease, expectorant, cough and lung disease, whooping cough, asthma, appetite loss, vomiting and stomach inflammation, indigestion, memory enhancer, weight loss and antibacterial. It is found in scientific sources with anti-viral, anti-inflammatory, estrogenic, antimutagenic, analgesic, antipyretic, anti-spasmolytic, anti-tumor, hepatoprotective, and hypolipidemic properties. There are about 4,500 species of high plants growing naturally in the territory of Uzbekistan, over 1,200 of those have medicinal properties. Currently, 112 types of medicinal plants are allowed to be used in official medicine in Uzbekistan, and 80% of them are plants growing naturally in mountain, sub-mountain and forestry areas (Resolution of the Cabinet of Ministers of the Republic of Uzbekistan 2013). Sharapov (2013) believed that if drinks a decoction made from white cumin fruit, those suffering from obesity will lose weight. Ibn Sino crushed cumin and used it to treat liver and spleen diseases. Cumin is widely used in modern medicine to treat inflammatory diseases of the bile ducts and gastrointestinal colds. In addition, galenic preparations prepared from its fruit are prescribed as a tonic, hemostatic, and healing agent for spleen tumors and stomatitis (Sharapov 2013). Tukhtaev & Ahmedov (2021) when planting medicinal fennel, add 50 tons of local rotted manure and 10 kg of phosphorus fertilizer per hectare to the soil in the fall, then cultivate with a plow at a depth of 25-30 cm. In early spring, 8-10 kg of fennel seeds with a fertility of not less than 95% are sown 1-2 cm deep planting is desirable per hectare. To create a uniform seedbed in the field, mixing the seed with river sand, humus, or wood chips will allow the seed to fall evenly. In order to get an abundant seed yield from fennel seeds, it is advisable to sow 70 cm between the rows, fennel seeds planted in early spring will germinate in 6-10 days depending on the weather (Tukhtaev & Ahmedov 2021). Karpuk (2011) reported that, Fennel fruit contains 4-6% essential oil, 60% atenol, 12-15% fencon, and the amount of unsaturated fats is 18%. Nizomova & Islamov (2018) before planting the fennel medicinal crop, 50 tons of local rotted manure and 10 kg ha^{-1} phosphoric fertilizer applied, and the soil was tilled to a depth of 35-40 cm in the fall, and 8-10 kg of well-sorted fennel seeds were planted per hectare at a depth of 1-2 cm. In order to ensure that the seed falls evenly on the field, it was considered

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MATERIALS AND METHODS

Medicinal white cumin plant was taken as a research object. Generally-accepted methods were used (Dospekhov 2011). Biometric measurements and analyses were performed. phenological observations were made by the method of Beydeman (1974). The initial periods of the main phases of plant development were recorded according to Beideman (1974) and carried out according to State standards. Results of soil analysis of the desert areas of Navoiy region were obtained. Before planting crops in the experimental area, soil samples were taken and chemically analyzed in order to determine the amount of nutrients in the soil. Soils of desert regions of Navoiy region when analyzed, the amount of humus in the arable layer (0-40 cm) was 0.760-0.192%, and these were low-

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quality soils. When the amount of N-NO_3 *(*nitrogen*)* was analyzed, it was 0.028-0.062% in the soil layer (0-40 cm), exhibiting a very low indicator according to the level of supply. The amount of P_2O_5 (phosphorus) in the arable layer (0-40 cm) was 2.67-4.0 mg kg^{-1} and was very little provided. According to the amount of K_2O (potassium), it was 34-132 mg kg^{-1} of the soil layer (0-40 cm), which was a very small amount according to the level of supply. Agro-climatic indicators of the Navoiy region indicated that the summer was hot and dry, the winter was moderate, and there was a large temperature fluctuation between daily and annual temperatures. The average monthly air temperature in the region was around +24.5 ºC. The highest temperature was in July-August, (+35.1-34.2 ºC), while the coldest was in December and January, (-8.4 ºC). The average monthly air temperature were 4.4, -5.8, 15.4, 19.2, 24.3, 31.5 and 31.5 ºC in January, February, March, April, small, June and July respectively. Relative air humidity were 60, 62, 52 and 61% on average in the 1^{st}, 2^{nd}, 3^{rd} and 4^{th} months; 46, 42, 32 and 40% in the 5^{th}, 6^{th}, 7^{th} and 8^{th} months. The monthly average speed of the wind was observed to be 1.1 m s^{-1}. Average monthly maximum wind speed was 11.0 m s^{-1}.

RESULTS AND DISCUSSION

In order to rapidly grow medicinal white cumin plant from seeds, $N_{20}P_{60}K_{40}$, $N_{40}P_{60}K_{40}$ and $N_{60}P_{60}K_{40}$ mineral fertilizer norms were used. A field without fertilizer was taken as a control treatment. In each treatment, protective furrows, observed model plants (at least 15) were determined, and phenological observation and biometric measurements of the plant were carried out (Fig. 1). Based on the results of study in 2022, the medicinal white cumin was fed twice during the vegetation period: the first was fed in late May and the second in mid-June, and yield (raw material) indicators were determined. Before sowing fennel seeds in mountain and desert regions, PYa-3-35 plough was plowed to a depth of 30-35 cm and leveled well with a harrow. After taking the furrows, fennel seeds were planted at the rate of 6 kg per hectare in the first control treatment, 6 kg in the second low-fertilized treatment, 8 kg in the third treatment with a slightly increased fertilizer rate, and finally 10 kg in the fourth treatment with a high fertilizer rate. It was planted in a row and scattered method at a depth of 1-2 cm. For uniform germination of fennel seeds, it was planted by mixing filing and humus. During our observations, it was found that the ability of seed germination is relatively high in mountainous and desert areas (60%). It turned out that lawns can easily compete with weeds. The plant was weeded 2 times during cultivation. When the plant bushes were planted in rows, 10-15 seeds per meter were irrigated 5 times during the season. In the first treatment, the fertilization system was carried out without fertilizer and in the specified three treatments and three returns. Based on the scientific research conducted, it was stated in the scientific reference that if agrotechnical measures are strictly followed, the yield of fennel seeds in irrigated areas and in dry land were 10-15 and 8-10 centners per hectare, respectively (Table 1).

Effects of agronomic practices on medicinal fennel seedlings and seed yield

The main part of the desert region is made up of heavy sandy, stony deserts, partly salty and barren. In such conditions, the changes in plants were observed using mineral fertilizers. As a result of our study, the following results were obtained when medicinal fennel seedlings were used according to the norms of mineral fertilizers for one model plant: the number of branches in the control (without fertilizer) treatment was 13.1; the number of flowers was 15.2 pieces and the length of the stem was equal to 120.3 cm. In the second treatment, when using different rates of mineral fertilizers, the number of branching, flower cluster and root length were 15.1, 16.1 and 162.1 cm respectively. In the third treatment, the number of branches, flower clusterand stem length were 18.2, 24.1 and 187.1 respectively. In the fourth treatment, the number of branches, number of flowers and root length were 19.3, 32.2 and 203.1 respectively. During the field condition in desert area, the effect of different rates of mineral fertilizers on fennel seedlings was as follows: In one model plant, compared to the control variant, the optimal branching was noted in 4 variants and produced 6.0 more branches. In proportion to the number of branching, the collection of flowers also had its own index, which was 17.0 stacks of flowers compared to the control. At the end of the experiment, it was revealed that the increase in biological mass also affected the root length, which was 120.3 cm in the control group, and 203.1 cm in the optimal treatment, which was 82.0 cm higher than the control. Wet and dry mass of fennel seedlings showed an increase in biological mass at high fertilizer rates, corresponding to the parameters of one model plant. After planting, 1326 kg ha^{-1} of fennel seeds were obtained in our control treatment, which was grown without additional treatments and without fertilizers (Fig. 2).

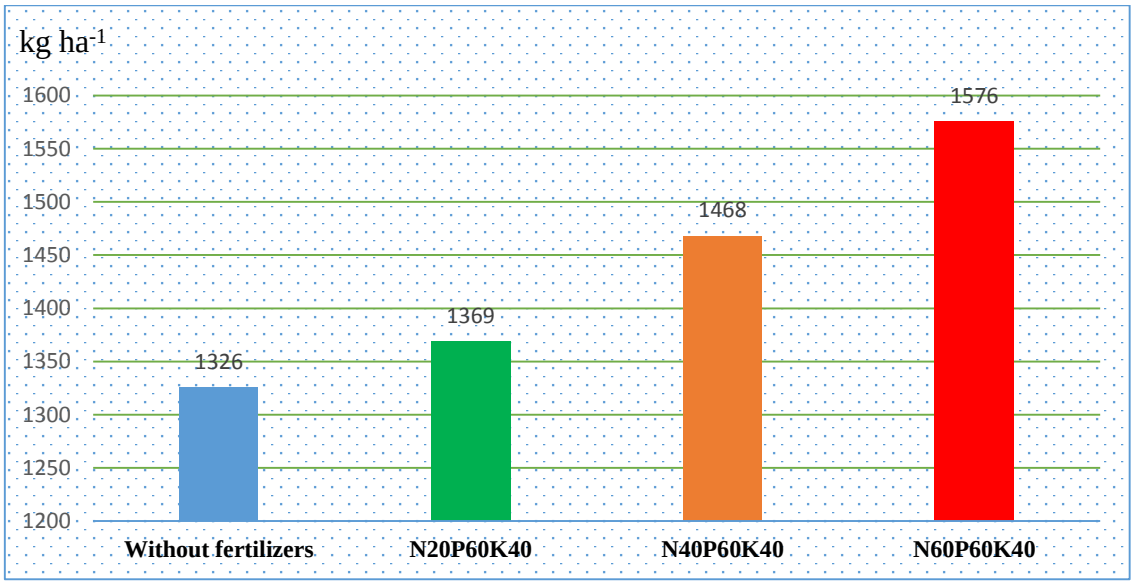

Fig. 2. Effect of mineral fertilizers on medicinal fennel seed yield (kg ha^{-1}).

A total of 1468 kg of fennel seeds were obtained in the third treatment, where the fertilizer ($N_{40}P_{60}$ K_{40}) was slightly increased. High biological mass compared to other variants displayed a positive effect on seed yield, and 1576 kg ha^{-1} were obtained (Table 1).

Table 1. Effects of agronomic practices on medicinal fennel seedlings and seed yield

Treatments	For one model plant			Fennel seedlings				Fennel seed yield	
	number of branches	a collection of flowers	root length cm	wet mass		dry mass		In 10 m^2 (kg)	kg ha^{-1}
				In 10 m^2 (g)	kg ha^{-1}	In 10 m^2 (g)	kg ha^{-1}		
Without fertilizer	13.1	15.2	120.3	5106.6	51066	2221.2	22212	132.6	1326
$N_{20}P_{60}K_{40}$	15.1	16.1	162.1	6849.0	68490	2844.6	28446	136.9	1369
$N_{40}P_{60}K_{40}$	18.2	24.1	187.1	11830.8	118308	4152.0	41520	146.8	1468
$N_{60}P_{60}K_{40}$	19.3	32.2	203.1	14209.8	142098	4725.0	47250	157.6	1576

The results obtained in the following years of our research are also unique: the number of branches in the first treatment (control) without fertilization was 15.0 pieces for one model plant; in the second treatment, where $N_{20}P_{60}K_{40}$ kg ha^{-1} was used, it was 16.0 pieces. According to the experimental scheme with 4 variants, by the increased $N_{60}P_{60}K_{40}$ exhibited 22.0 branches, 7 more branches compared to the control. The number of flowers and root length were proportionally increased when the fertilizer rate was upraised, hence, 23 flower clusters displayed 173.0-cm long roots compared to the control.

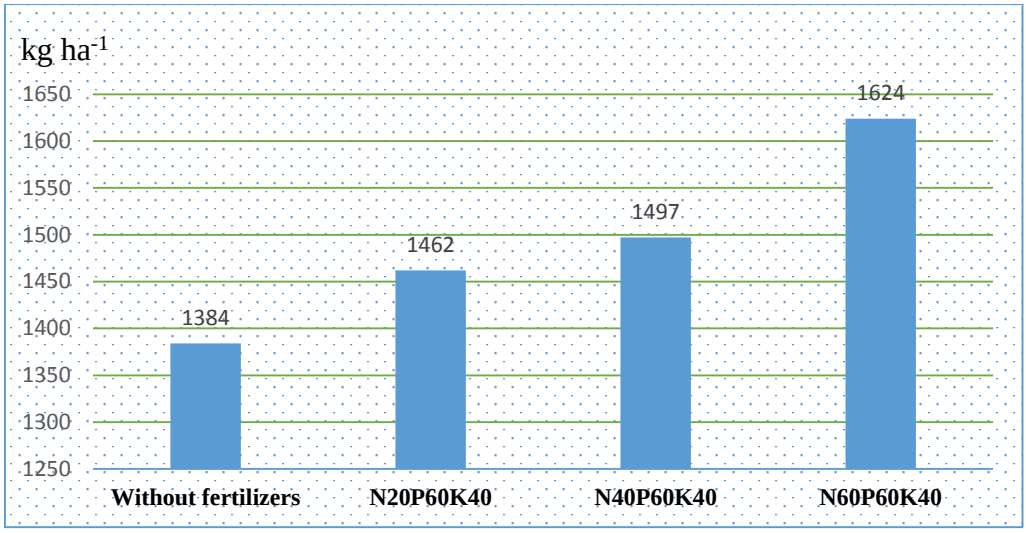

Fig. 3. Effect of mineral fertilizers on medicinal fennel seed yield (kg ha^{-1}).

In the following years of the present study, the weather was acceptable for the development of fennel growth, and the seed yield was slightly higher than in previous years. In the non-fertilized treatment, 1,384 kg ha^{-1} fennel seeds were obtained, while in the second treatment, 1,462.0 kg ha^{-1} were obtained with $N_{20}P_{60}K_{40}$; and 1497 kg ha^{-1} when $N_{40}P_{60}K_{40}$ was applied (Fig. 3).

Table 2. Effects of agronomic practices on medicinal fennel seedlings and seed yield.

Treatments	For one model plant			Fennel seedlings				Fennel seed yield	
	Number of branches	A collection of flowers	Root length (cm)	Wet mass		Dry mass		In 10 m^2 (g)	kg ha^{-1}
				In 10 m^2 (g)	kg ha^{-1}	In 10 m^2 (g)	kg ha^{-1}		
Without fertilizer	15.0	16.0	212.0	6800.7	68007	3294.0	32940	138.4	1384
$N_{20}P_{60}K_{40}$	16.0	22.0	287.0	7990.1	79901	4001.0	40010	146.2	1462
$N_{40}P_{60}K_{40}$	18.0	28.0	329.0	11490.6	114906	5454.0	54540	149.7	1497
$N_{60}P_{60}K_{40}$	22.0	39.0	385.0	12980.4	129804	6008.0	60080	162.4	1624

From the fennel seeds obtained in all years, those obtained in 2022 exhibited a higher yield, and according to the course of scientific study, 1624 kg ha^{-1} fennel seeds could be obtained (Table 2).

CONCLUSION

Summarizing our study in the desert and mountain regions, it should be mentioned that based on the results of our research, it is possible to grow medicinal fennel plant not only in the irrigated lands, but also in the desert and mountain regions of Uzbekistan. In this study, we developed an agrotechnology for the effective use of unused lands in the foothills desert regions and for obtaining abundant harvests from medicinal fennel seeds. In our 4th treatment, where the rate of fertilizer $N_{60}P_{60}K_{40}$ was increased, the excess of biological mass compared to other treatments was reflected in our seed yield at the end of the fennel vegetation, and 1624 kg ha^{-1} fennel seeds were obtained.

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