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Article

Introduction and Agrotechnology of Greek Chambala (Trigonella Foenum-Graecum L.) in Surkhondaryo Region

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Abstract: This research explores the introduction and agrotechnology of Greek Chambala (Trigonella foenum-graecum L.) in the Surkhandarya region of Uzbekistan. The study focuses on the growth development and medicinal properties of this leguminous herb, with particular emphasis on agrotechnological factors such as planting dates, row spacing, and chemical protection measures that influence productivity. Greek Chambala is valued for its bioactive compounds, known for medicinal benefits like managing diabetes and obesity. The experiment was conducted at the "Jonchekka Sarhadlari" farm using different planting configurations and fertilization methods. The results showed that planting in November yielded optimal seed development and contributed to soil fertility through nitrogen fixation. The findings provide practical insights for enhancing the cultivation of Greek Chambala in Surkhandarya's climatic conditions, making it a promising crop for both agricultural and medicinal purposes.

Keywords: Greek Shambala, Trigonella Foenum-Graecum, Fenugreek, Seed Development, Medicinal Properties, Row Spacing, Planting Dates, Surkhandarya, Nitrogen Fixation, Bioactive Compounds.

1. Introduction

Decree of the President of the Republic of Uzbekistan dated November 26, 2020, titled "On measures to expand the scope of scientific research on the cultivation and processing of medicinal plants, and the development of their seed production," outlines decision No. PQ-4901. This decree mandates the establishment of a centralised database for scientific research on the cultivation and processing of medicinal plants within the Republic, the examination of advanced scientific developments from foreign nations, the formation of partnerships with leading scientific institutions, the implementation of modern technologies, the scientific introduction of developments within the Republic, and the enhancement of the effective utilisation of existing resources. Additionally, it references the measures outlined in the President's decree dated April 10, 2020, concerning the protection, cultivation, processing, and rational use of wild medicinal plant resources. Decision No. PQ-4670 established a conducive environment for the advancement of medicinal plant cultivation and processing, aimed at enhancing the industry's export potential and facilitating the integration of education, science, and production processes. The purposes of the provision are delineated.

Greek shambala is an ancient, versatile crop cultivated across several geographic regions. Greek shambala (Trigonella foenum-graecum L.) is an annual leguminous plant

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of the Fabaceae family. This plant is cultivated in Europe, India, Turkey, China, Canada, Australia, Russia, and northwestern Africa. The seeds possess a potent aroma and exhibit a bitter flavour, being exceptionally hard and difficult to ground. Fenugreek seeds are frequently utilised in traditional medicine as a laxative, digestive aid, and treatment for coughs and bronchitis. They can also assist in regulating cholesterol, triglycerides, and elevated blood glucose levels in individuals with diabetes. The addition of gruel seeds to cereal and wheat flour, or their administration to nursing women, can enhance breast milk production. Excessive intake of fenugreek seeds by pregnant women may elevate their chance of premature birth [5].

Fenugreek seeds provide a substantial protein content of approximately 20-30% and are abundant in lysine and tryptophan. Fenugreek seeds provide 45-60% carbohydrates, predominantly mucilaginous fibre, consisting of 30% soluble and 20% insoluble fibre. They also comprise minor quantities of oils (5-10%) and pyridine alkaloids (predominantly trigonelline), various flavonoids, free amino acids, sapogenins, vitamins, and volatile oils. Fenugreek seeds provide nutrients including copper, potassium, calcium, iron, selenium, zinc, manganese, and magnesium. Potassium is a crucial element in cells and bodily fluids, aiding in the regulation of heart rate and blood pressure by mitigating the effects of salt. Iron is essential for the synthesis of red blood cells.

Information on the average germination of the seeds of the one-year medicinal plant Trigonella foenum-graecum L., introduced to the Tashkent Botanical Garden, in three different conditions, the most favorable temperature for germination, and the energy of germination is presented. In this case, it was determined that the germination rate of the species under thermostat conditions was on average 91.6%, and the growth energy was 53.3%. According to the results of the research, it was known that the possibility of planting and using this species in field conditions is high. [8]

Greek shambala (Trigonella foenum-graecum L.) is an annual, medicinal legume. It is cultivated on every continent, across various soil and climatic conditions. There has been an increasing interest in the creation of Greek shambala, particularly in North America and Europe. This crop is notably recognised for enhancing soil fertility through atmospheric nitrogen fixation, hence reducing the need for nitrogen fertilisers in succeeding crops (Basu et al., 2004; Khan et al., 2014; Kolodziej and Zejdan, 2000). The planting date and row spacing are two critical agronomic elements that directly influence productivity. Generally, early planting dates are favoured because to their anticipated positive impacts on seed germination, growth and development, duration of the growing season, and ultimately, production. (Matelic & Jevdjovic, 2007; Pandita & Randhawa, 1994; Sheoran et al., 2000).

2. Materials and Methods

Materials and Methods. The subject of the experiment was the fenugreek plant. The plants were cultivated in the experimental fields of the "Jonchekka Sarhadlari" farm (38°22'46.1"N 68°05'32.5"E) located in the Uzun district of the Surkhandarya area (Fig. 1). Fenugreek seeds were procured over two seasons of agricultural trials. The experiment was performed on a standard type IVa brown soil featuring a light sandy layer. The soil exhibited a mildly acidic pH, moderate concentrations of phosphate and potassium, and low concentrations of magnesium. Nitrogen concentration is 1.13 g per 1 kilogramme of soil.

3. Results and Discussion

Illustration 1.

The subsequent mineral fertilisers were utilised: 30 kilogramme N ha−1 (urea), 30.5 kg P ha−1 (46% granular triple superphosphate), and 83 kg K ha−1 (60% potassium salt). The harvested seeds were cleaned, thereafter dried to 12% moisture (± 0.5%), and brought to the laboratory, where they were stored at 7 °C. Prior to the experiment, the moisture content of the seeds was measured many times. All evaluated physical parameters were assessed at 12% seed moisture content.

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In the course of mathematical statistical analysis, the calculated productivity and other indicators of all experimental results after planting Greek shambala in the open field were subjected to mathematical-statistical processing according to the method recommended by scientists such as B.A.Dospekhov [14] and G.N.Zaysev [15].

Botanical description. Significant discrepancies exist in the claimed number of Shambhala species in the literature; nonetheless, earlier taxonomies, including those of Linnaeus, have been examined to distinctly highlight the existence of 260 species [9]. The species of Greek shambala recognised primarily for their medical and pharmacological attributes include: T. foenum-graecum, T. balansae, T. corniculata, T. maritima, T. spicata, T. occulta, T. polycerata, T. calliceras, T. cretica, T. caerulea, T. lilacina, T. radiata, and T. spinosa. T. foenum-graecum is extensively farmed globally. The genus name, Trigonella, translates to "little triangle," referencing the triangular shape of its little yellowish-white blooms. The species is named foenum-graecum, which translates to "Greek hay," due to its first arrival from Greece, which has been established as the cause [9]. Various local denominations are assigned to the plant based on the communities, languages, and cultures in which it is cultivated or utilised. Fenugreek is referred to as "Hulba" in Arabic, Shambalilae in Persian, Tili, Tipilina, Trigoniskos, Tintelis, Tsimeni, and Moschositaro in Greek, Boidana, Ul'ba, and Khul'ba in Uzbek, Shambala in Armenian, K'u-Tou in Chinese, Abish in Ethiopian, Koroba in Japanese, fenugreek or Fenigrec in English, Methi in Pakistani and Indian languages, Fieno Greco in Italian, Pazjitnik in Russian, and Senegre in French.

The agronomic production of Greek shambala crops has been extensively researched and documented in arid and semi-arid environments globally, as evidenced in the original literature [12, 13]. Climatic and edaphic environmental influences, and genetic composition Crop pests, fungi, bacteria, and abiotic illnesses, including micronutrient shortages, floods, salt, and stagnant water, have been identified as influential biological variables. [16].

Agrotechnological practices for cultivation. The root is anchored, branching, and penetrates the subterranean layer. The stem is straight, somewhat branching, cylindrical, hairy, green, and contains anthocyanin, measuring 25-60 cm in length. Leaves are ovate to widely lanceolate, serrated, and glabrous, about 24 cm in length. The petals are nearly double the length of the corolla. The fruit is a pod, slightly curved, smooth, measuring 6-16 cm in length, and turns brown upon maturing. The seeds measure 46 mm in length and exhibit green and yellow colouration. The mass of 1000 seeds ranges from 14 to 16 grammes, with 1 gramme containing 60 to 70 seeds. (Figure 2).

The plant is an annual species, early-maturing, highly drought-resistant, requires warm temperatures, and is adaptable to many growth circumstances. Consequently, certain forms and biotypes can be cultivated around 60° north latitude.

Figure 2.

Seeds remain viable for 8-10 years in the south and 3-5 years in the north. Seedlings appear after 7-8 days, with a lack of moisture in the soil - after 15-18 days. Seedlings are affected by late frost.

In dry places, growth processes are reduced and ripening is accelerated. At this time, the height of polymorphic plants is 25-30 cm, in years when moisture and watering are convenient - 45-60 cm, in later forms - 70-80 cm, they respond positively to moisture and fertilizers. It is not difficult for soils, only heavy, floating, acidic, flooded soils are not suitable. Most of its ecotypes and geographical forms are not affected by diseases and pests.

According to the technology of cultivation for food and seeds, it differs little from other southern annual legumes. Field, farm, fodder and vegetables are placed in rotation. Organic and mineral fertilizers are used in the main plowing. Autumn sowing - in warm places, in spring - after early ear crops, in summer - after harvesting early varieties of straw, grain and fodder crops. Sowing methods: for fodder - row, for seed - wide row (45 cm), for fodder mixed with other grasses - alternate row. Seeding rate per hectare: for feed and green manure - 20-25 kg, for seeds - 10-14, mixed with other herbs - 6-8 kg.

Figure 3. Green fodder and hay are harvested at the beginning of flowering.

Later harvesting increases the specific smell and reduces the taste. When 60-70% of the beans are brown, they are harvested for seed. Delay results in seed loss due to cracking (Figure 3).

In Kavkazorti, the yield of green mass is 20-24 t/ha, when harvesting straw - 8-10 t/ha, during autumn harvesting (with spring harvesting) - up to 20 t/ha. In dry years, in

the steppe part of the Kuban, they are 8-12 t/ha, in the Moscow region - 14-20 t/ha. Seed yield - 0.5 t/ha. The seeds are very nutritious.

Place in crop rotation. Greek shambalas, cotton, and other crops are planted on vacant land. It is better not to plant hemp, rice, corn, pulses, and vegetables with the same roots as alfalfa.

Preparing the land for planting. During the vegetation period, plants go through certain phenological phases of development. According to the number of days spent in the phenological phase, plants are usually divided into early, middle and late. Of the three listed groups, the species and varieties of early plants are important for the Surkhandarya oasis. Due to natural and climatic conditions, Surkhondaro region is included in the favorable agricultural zone. Sufficient heat, return of cold air, frosts in late spring and early summer adversely affect the growth and development of plants, especially heat-loving plants moved from southern latitudes; shortens the growing season and plants do not have time to form mature seeds, which significantly slows down the introduction of cultivated species into the crop.

Figure 4

The soil for cultivating Greek shambala is tilled in the autumn. Autumn tillage is contingent upon the preceding crop type. Considering the soil's moisture content, irrigation of the preceding crop post-harvest facilitates subsequent land cultivation. In cultivated areas, following irrigation, the soil is tilled to a depth of 28-30 cm. Following the irrigation of the weed-infested soil, it is cultivated to a depth of 7-9 cm by a plough equipped with a specialised tipper or a conventional plough. This action retains moisture in the topsoil, maintains a weed and pest-free field, causes the grass seeds to germinate, and then vanish when ploughed

Mineral and organic fertilisers are applied prior to ploughing. In spring, the plough is harrowed to retain soil moisture and eliminate weeds from the field. It is preferable to utilise a volokusha or a plume mola rather of a harrow. Utilisation of these equipment ensures a well-leveled field surface and preservation of soil structure. A light or medium-heavy harrow is utilised based on the soil type and density. When the weeds have proliferated significantly, cultivation is undertaken. A harrow is affixed to the cultivator, followed by the pressing of a trowel over the porous soil to ensure equal seed sowing.

When the Greek shambala is cultivated in salty soils, the salt must be removed. The terrain designated for Greek shambala cultivation must be level and free of debris.

Fertilisation. As a leguminous plant, Greek shambala requires less mineral nitrogen. Since shambala collects nitrogen, it necessitates increased phosphorus and potassium fertilisers. As with all medicinal plants, Greek shambala is utilised in specific, prescribed

dosages. During the early phases of development, shambala requires substantial phosphorus. If phosphorus is adequate during this phase, shambala will thrive in later phases as well. The impact of potassium is inferior than that of phosphorus; therefore, the outcome is enhanced when both are utilised concurrently. It is advisable to apply 30-80 kg of phosphorus and 80-120 kg of potassium per hectare, contingent upon soil type and productivity.

Findings from the research. In the Surkhandarya region, Greek shambala (Trigonella foenum-graecum) seeds were sorted in autumn 2023, followed by the ploughing and preparation of the land for planting. Stratification for early seed collecting was unnecessary. In this instance, early autumn planting constituted the foundation.

On November 24, 2023, we sowed the seeds of Greek shambala. Row width was established in configurations of 40x10 cm, 50x10 cm, and 60x10 cm. The seeds commenced germination on December 10 during the preliminary phase. The growth of Greek shambalas diminished throughout the winter season, akin to other crops, although persisted in development on warmer days. Shambala maintained its flora during the harsh winter days. The elevated carbohydrate content significantly contributed to this. In early spring, he advanced the phase of plant development and initiated the vegetation season extensively. Stem branching was noted in Shambala, similar to other legumes. Consequently, due to the plant's production of sympodial branches, white to yellow blooms commenced appearing on the harvest branches starting March 5, 2024. The development of flowers occurred uniformly. The flowering of the Shambala plant persists until March 25. On average, each bush produced 3 to 5 stems, with 2 flowers developing on each stalk.

During the study, the phenological characteristics of the development of Greek fenugreek were observed. The results obtained during the experiment are presented in Table 1, which shows all the phenological phases: from germination to mass fruiting. As a control, the Gurman variety of fenugreek was taken.

As can be seen from Table 1, the "blooming" stage began almost simultaneously in all studied plants. Significant differences in variants were observed during the transition of plants to the generative stage of development. The vascularization phase was previously observed in option 1. In option 3, the final transition to the vascularization stage was observed. From the flowering stage, the differences between the options began to increase: in option 3, the beginning of flowering occurred 3 days later than option 2 and 6 days later than option 1. Mass flowering of fenugreek variant 1 occurred on March 17, variant 2 on March 19, variant 3 on March 21 and variant 4 on March 18.

Table 1. Features of phenological development. Greek shambala, 2023-2024

Phenological stages	Experiment options (Greek fenugreek)			
	1. var. (nazorat)	2. var.	3.var.	4. var.
	Beginning dates of phenological phases			
1. Bruising	5.12 2023	5.12 2023	5.12 2023	5.12 2023
2. Vascular shooting	8.12 2023	10.12 2023	11.12 2023	10.12 2023
3. Flowering: Start	3.03 2024	6.03 2024	9.03 2024	5.03 2024
Public	17.03 2024	19.03 2024	21.03 2024	18.03 2024

When introducing transplanted plants from other regions with a complex of natural and climatic conditions, the ability of plants to go through all stages of ontogenesis and to produce ripe seeds with high germination during the growing season is of great importance. This significantly speeds up the process of introducing the studied plant into culture.

Based on the transition characteristics of the phenological phases, the duration of the generative stages of the Greek shambala was determined (Table 2). It was found that in variant 1 all phenological phases occurred much earlier than in the other three variants. As a result, the period from the germination phase to the mass flowering phase was 104 days, which is 11 days less than variant 4 and 15 days less than variant 3.

The longest vegetation period (from the flowering phase to the mass flowering phase) was observed for the Greek shambala variant 3, which was 113 days.

Table 2. The dynamics of continuity generative stages of fenugreek

Phenological stages	Experiment options (Greek fenugreek)			
	1. var. (control)	2. var.	3.var.	4.var.
	Time from germination to (days):			
1. Vascular shooting	34	32	33	36
2. Flowering:	44	43	42	43
Start				
Public	40	41	44	40

4. Conclusion

The study showed that in the soil climate of Surkhandarya region, it is recommended to plant Greek shambala in November, in which the root nodules of shambala developed well, which led to good accumulation of nitrogen in the soil. In the Surkhandarya region, flowering was observed in March when sowing in the autumn term, and seed ripening in April, and in May and June in the spring term, respectively. The growth period was 60-120 days. From the four studied options for cultivation in the natural climatic conditions of the Surkhandarya region, we can recommend to the Greek population in the form of option 1, the Gurman variety from Egypt, which differs from the other three options by the earlier passage of all stages.

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