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SEED YIELD AND QUALITY INDICATORS OF THE "OTAVNIY" SAINFOIN CULTIVAR UNDER DIFFERENT ECOLOGICAL CONDITIONS

Djamolova U., Rabbimov A.

Karakul Sheep Breeding and Desert Ecology Research Institute, Samarkand, Mirzo Ulugbek Street, 47.

E-mail: uzkarakul30@mail.ru

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ABSTRACT

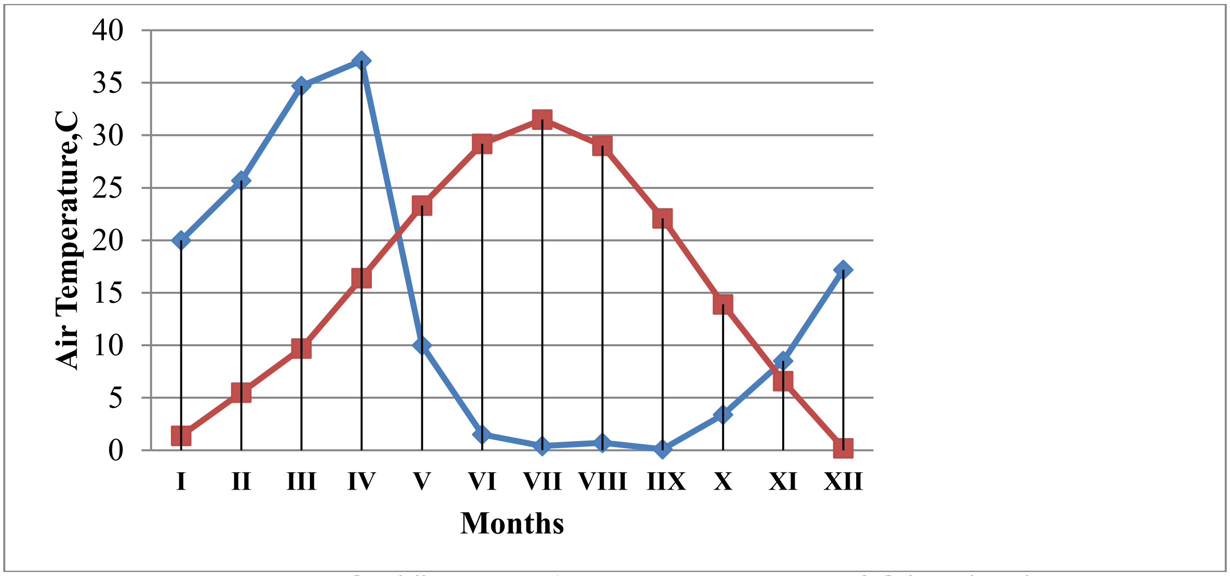
This article presents data on the growth, development, individual seed yield, and seed quality of the "Otavniy" sainfoin cultivar, a desert forage plant species, under various ecological conditions.

INTRODUCTION

Upland and desert pastures in Uzbekistan are the primary forage resource for pastoral farming, utilized almost year-round. Pasture productivity fluctuates dramatically from year to year, directly correlating with annual rainfall. Furthermore, pasture yield and forage quality vary throughout the year. Pastoral farming is a crucial sector in ensuring the country's food security, and its sustainable development is a pressing national priority. This sustainable development is directly linked to the robustness of forage reserves. It is crucial to emphasize that desert ecosystems are environmentally fragile; any economic activity in these areas can lead to pasture degradation and accelerated desertification. Currently, desertification is rampant across vast areas of Uzbekistan's pastures, resulting in a decrease in the number of forage species and a reduction in pasture productivity by 20-40% or more in various regions [7]. In light of this, the Uzbek President and Government have set urgent tasks for implementing a range of measures. For example, the Resolution of the President of the Republic of Uzbekistan PQ-277 of June 10, 2022, "On developing effective measures to combat land degradation," sets a target to restore the productivity of approximately 2.5 million hectares of severely degraded pastures through phytoremediation of plant cover by 2025. To achieve this, at least 25,000 tons of seeds of desert forage plant species and varieties are needed. This, in turn, necessitates the rapid development of seed production of desert forage plant species and varieties, and the scientifically based zoning of varietal seed production fields, taking into account the ecological and biological characteristics of plants, to ensure abundant, high-quality seed production. Among the promising forage plant species for pasture phytoremediation is sainfoin (Kochia prostrata (L.) Schrad.), with several varieties such as "Malguzarskiy-83", "Karnabchulskiy", "Pustynnyy", "Otavniy", "Saxro", and "Nurota" developed and registered in the State Register. These varieties are based on different ecological types of sainfoin, and each variety is recommended for cultivation in specific soil and climatic conditions. Therefore, it is advisable to establish seed production fields for each variety in regions with optimal conditions for that specific variety.

Research Object and Methods: The research object was the "Otavniy" sainfoin variety. Research was conducted under the conditions of the wormwood-ephemeral Karnab desert and the Nurata foothills. To comparatively study the growth, development, and yield characteristics of plants in different ecological regions, generally accepted methods in plant science [2,9] were used on plants of the same age (3 years old). Seed yield was studied individually in 20 plants grown in each region. Seed purity, germination rate, and the absolute mass of 1000 seeds were assessed using generally accepted seed science methods [2,3,4,10].

Analysis of Research Results: The Karnab experimental field of the Institute is located in the Karnab desert, a wormwood-ephemeral area covering 500,000 hectares. The Karnab desert occupies the southern part of the Zirabulak mountains on the left bank of the Zarafshan River, at an altitude of 310 m above sea level. In scientific literature, this area is referred to as the "Karnab steppe". Climatically, the Karnab desert is characterized by a Mediterranean climate type. The relief of the Karnab desert is generally flat, sloping from east to west, except for the northern part (mountain slopes), which is undulating with numerous streams and temporary watercourses.



Rainfall: 167.1 mm; Average air temperature: 17.1°C; Relative humidity: 30%

Figure 1. Climatogram of the experimental area (based on data from the Muborak meteorological station).

The highest air temperatures occur in June and July, reaching +40°C to +47°C in the shade. The lowest temperatures are observed in December-February, sometimes reaching -20°C to -30°C. The average annual relative humidity is 30%, often falling below 10-20% in summer. The climate diagram clearly shows distinct dry and humid seasons. Most rainfall occurs between November and April. Average annual rainfall varies from 81.9 to 297.4 mm, with a long-term average of 162.0 mm.

Morphological Structure of Soils: Karnab desert soils are classified as light-colored gray soils. In the light-colored gray soil zone, average annual rainfall is 200-300 mm. Salts in the topsoil are not effectively leached; a saline layer is found at a certain depth, approximately 40-60 cm, and sometimes even at 1-2 m below the surface. Light-colored gray soils are relatively poor in organic matter compared to soils in other regions. Humus content in the arable layer ranges from 0.5% to 1.5%. Light-colored gray soils constitute 10% of the total arable land (cultivated land) and 18% of the total irrigated area in the region. A large part of the newly irrigated lands (in the Mirzachul, Jizzakh, and Karshi deserts) consists of light-colored gray soils. These soils do not have good granulation but are characterized by good water permeability and high capillarity. Therefore, on slightly sloping land, light-colored gray soils are desalinated by leaching, but in flat areas, excessive irrigation and other factors cause the saline groundwater to rise to the surface, leading to re-salinization. This situation necessitates the implementation of measures such as digging collector ditches to lower the water table, leaching soil salinity, strictly regulating irrigation regimes, land leveling, crop rotation, creating windbreaks, and other measures. Gray soils in this region are low in humus, nitrogen, and phosphorus; organic matter mineralizes rapidly. Soil structure is not very strong. However, the natural fertility of these soils is significantly higher than that of soils in flat desert areas.

Mechanical and Mineralogical Composition: Due to the formation of light gray-brown soils from various parent materials, their mechanical composition varies, with sandy loam and light sandy loam types being most common. Angular gravel stones are often found on the surface of these soils. The upper layers of soil are characterized by a high proportion of fine sand and coarse silt fractions, while the illuvial horizon contains a high proportion (11-18%) of clay particles smaller than 0.001 mm. A significant portion of the Karnab desert soils consists of light grayish-brown soils. Gypsum salinity is quite high in these soils (at a depth of 50-60 cm), and the humus content is also substantial—1.17%. The main mass of carbonates lies at a depth of 10-20 cm, decreasing with depth. The mechanical composition of light grayish-brown and grayish-brown soils is diverse. In terms of mechanical composition, Karnab desert soils are classified into the following types: sandy loam-silt light grayish-brown soils, soils with saline deluvial-proluvial layers, gypsum-sandy light grayish-brown soils, etc. All soil types are characterized by layered stratification in terms of density, mechanical composition, and salt content. Layers of light clay alternate with layers of medium clay, sandy loam, and others. In some layers, the clay content with a size of 0.001 mm reaches 21%.

Plant Cover: In the Karnab desert plant cover, along with the wormwood-ephemeral plant group, groups composed solely of ephemeral grasses are also found. This is due to the soil's chemical and mechanical properties. However, the Karnab desert plant cover is characterized by the co-occurrence of wormwood, ephemeral, and ephemeroid species, forming a single plant community (phytocenosis). Central Asian desert plant cover is divided into four main types based on characteristics: shrub-herb; herb-saline; semi-shrub-ephemeral; and ephemeral. Overall, the desert region's plant cover is distinguished by its diversity of life forms and species. For example, according to the research of S. Mavlonov [5], 238 species of flowering plants were recorded in the Karnab desert flora. These plant species belong to 138 genera, of which 216 species (90.8%) are herbaceous plants, 12 species (5.0%) are semi-shrubs, and 10 species (4.2%) are shrubs. The most common species in the plant cover of the research area include: wormwood – Artemisia diffusa Krasch. ex Poljak, A. turanica Krasch, Salsola orientalis S. Gmel., Halothamnus subaphylla (G.A. Mey), Carex pachystulis L., Gagea stipitata Merkel. ex Bunge; Ferula assa-foetida (Bunge) Regel, Anisantha tectorum (L). Nevski, Bromus danthoniae Trin, Malcolmia turkestanica Litv., Trigonella noeana Boiss., Leptoleum filifolium (Willd) DS., various species of Eremopyrum – Eremopyrum orientale (L.) Gaub. l Spach, E. hirsutum (Bertel.)Nevski, and many others. The natural flora of the Karnab desert includes annual saline grasses such as Salsola scleranta, Climacoptera lanata, and Halocharis hispida, and coarse-stemmed plants such as Alhagi pseudalhagi (manna-grass) and Cousinia resinosa. Wormwood-ephemeral Karnab desert pastures are dominated by wormwood, with ephemeral grasses accounting for only 15-20%. In spring, these ephemeral grasses constitute 40-50% of the diet of Karakul sheep. Forage reserves in such pastures vary significantly from year to year and throughout the seasons, ranging from 1.6-3.0 centners of dry matter per hectare. A forage shortage occurs especially in autumn and winter, highlighting the importance of creating high-yielding autumn-winter pastures.

"Nurata" Experimental Field: This experimental field is located in the Nurata district of Navoiy region. The research site is in the lower foothills of the Nurata mountain range, at an altitude of 600-780 meters above sea level. The Nurata mountains are the westernmost part of the Pamir-Alay mountain system, bordered to the north and northwest by the Kyzylkum Desert, and to the east by the Malygdar and Turkestan mountain ranges.

Climate: Due to its distance from open water bodies and its direct connection to the Kyzylkum Desert, the Nurata oasis has a sharply continental and extremely arid climate. The average annual air temperature is 13.8°C, with considerable interannual variability; the absolute maximum is around +46.7°C, and the absolute minimum is around -24.0°C. The average annual rainfall is slightly higher than in the Karnab experimental field, at 206 mm, mainly occurring in winter and spring. The average annual relative humidity is 35.4%. Winds mostly blow from the north, increasing in speed after midday.

Soils: Various soil types are found in the desert, foothill, and mountain regions of the Nurata district of Navoiy region. The soil type of the experimental field is light gray soil; the underlying layers, consisting of fine-grained sands and cemented deposits, are the soil-forming parent material.

The water absorption properties of the Nurata experimental field soils are described based on the data of Kh.R. Khalilov and J.Q. Qo'ng'irov [12]. The southwestern part of the experimental field has a gentle slope from south to north; groundwater is located at a depth of 60-70 meters.

The soil is predominantly composed of coarse and fine sand (up to 94%), with coarse silt accounting for 0.7-6.9% and silty particles for 4.3-9.5%. The surface layer is virtually salt-free, while a slight increase in salt content (0.426% solid residue) is observed in the 102-230 cm layer. Humus content is relatively high (0.80%) in the surface layer but decreases by half (0.40%) in the subsequent (28-102 cm) layers and does not exceed 0.35-0.21% in deeper layers. Total nitrogen content is also higher in the surface layers (0.061%), decreasing to around 0.021-0.017% in deeper layers. Available phosphorus in the soil layers ranges from 0.040-0.075%, while total potassium is 1.6-1.7%. Readily available phosphorus and potassium are relatively higher in the topsoil (0-62 cm) (10.5-12.0 and 206.0-220 mg/kg), significantly decreasing in deeper layers. Thus, the soils of the Nurata experimental field are typical of the foothill region, non-saline, with favorable granulometric composition, but relatively poor in humus and other nutrients.

The current state of degraded pasture soils prevalent in the Nurata district, including their morphogenetic, agrochemical, physicochemical, microbiological, and enzymatic properties, has been determined. It has been concluded that increasing soil fertility and improving pasture conditions is possible through the establishment of agrophytocenoses from a mixture of shrub, semi-shrub, and perennial herbaceous plants [6].

Vegetation: The Nurata foothill semi-desert (upland) areas are predominantly characterized by ephemeroid-type pastures: ephemeroid-mixed herbaceous and ephemeroid-wormwood pastures. The plant cover primarily consists of Carex pachystylis Gay (sedge), Poa bulbosa L. (bulbous bluegrass), Artemisia diffusa Krasch ex Poljak (wormwood), Phlomis thapsoides Bunge (Jerusalem sage), Alhagi pseudalhagi (Rieb) Fisch (manna-grass), Peganum harmala L. (harmala), Malcolmia hispida Litv. (bittercress), Anisantha tectorum L. (brome), and others.

However, these pastures suffer from several drawbacks: they are low-yielding, with productivity varying significantly throughout the year and between seasons. Overgrazing and unsustainable use of vegetation have led to a decrease in high-yielding species with important nutritional properties. Forage plant species have become sparse or have been replaced by low-yielding, less nutritious species.

“Otavniy” Sainfoin Cultivar: This sainfoin cultivar belongs to the stony (var. canescens) ecological type and was developed using individual-group selection from a wild population found in the Jingeldisoy massif of Osh Oblast, Kyrgyzstan. The population consists of semi-erect plants. The stems are round, with a basal diameter of 2.5-3.5 mm and a length of up to 85-105 cm, with moderately dense pubescence. The plants are strongly tufted, with each mature plant producing 95-130 stems. The leaves are lanceolate, with moderately dense pubescence, 2.0-2.5 mm wide and 2.5-3.5 cm long; during flowering, leaves constitute 44.3% of the biomass, and during seed formation, 16.6%. The inflorescence is racemose, branched, 35-45 cm long. It develops a strongly developed taproot system of the universal type, penetrating the soil to a depth of 7-8 m (Figure 1).

Figure 1. Individual plant of Sainfoin cultivar “Otavniy”. Nurata foothills conditions.

During the budding stage, the forage was found to contain 12-16% crude protein, 2.7-3.28% fat, 43.5% nitrogen-free extract (NFE), and 26.5-30.8% fiber. Depending on the season, the forage retained 63.5-45.9 feed units. After cutting during flowering, it possesses the ability to regrow and produce seeds. The hay yield of the cultivar was determined to be 16-18 tons/ha with two cuttings in its third year, while the seed yield was 1.7-2.7 tons/ha, with a vegetation period of 220-250 days. This sainfoin cultivar is recommended for creating artificial hayfields and high-yield pasture agrophytocenoses in the ephemeroid-desert zone with annual rainfall of 110-350 mm [8,11].

The research data indicate that the "Otavniy" sainfoin cultivar is better adapted to the soil and climatic conditions of the Karnab desert and that this region is optimal for this cultivar. This was clearly demonstrated in the plant's growth, development, seed yield, and seed quality indicators. As shown in Table 1, the height of 3-year-old plants in the Karnab desert reached 86 cm, while in the Nurata foothills it was 67.8 cm. The number of generative shoots, which determines seed productivity, averaged 68 per plant in the Karnab desert, compared to an average of 54 per plant in the Nurata foothills..

Table-1.
Seed Quality Indicators of Sainfoin Cultivar "Otavniy" Grown Under Different Ecological Conditions.
Karnab and Nurata Experimental Fields, 2022.

Indications	Qarnabchul	Nurata foothills
Plants height, cm	86,2±2,4	67,8 ± 2,7
Number of generative twigs, pieces/Bush	68,4±7,1	54,4 ± 6,1
Individual dry phytomassas, g / tup	132,0±25,3	123,2± 14,2
Individual seed harvest, g / tup	51,0±6,2	33,1 ± 4,5

A similar trend was observed in plant biomass and seed yield. The "Otavniy" sainfoin variety exhibited higher biomass and seed yield in the Karnab desert's soil and climatic conditions compared to the Nurata foothills. Selecting optimal regions for establishing seed production fields, based on the plant's ecological and biological characteristics, ensures higher seed yields and quality. A comparative assessment of seed quality indicators from both regions further supports the Karnab desert's soil and climate as optimal for the "Otavniy" sainfoin variety from a seed production perspective. As shown in Table 2, the absolute mass of 1000 seeds—a crucial quality indicator—was 2.1 g for seeds grown in the Karnab desert, compared to 1.8 g for those grown in the Nurata foothills.

Table-2
Seed Quality Indicators of the "Otavniy" Sainfoin Cultivar Grown Under Different Ecological Conditions.
Karnab and Nurata Experimental Fields, 2022..

Indications	Qarnabchul	Nurata foothills
Seed purity, %	32,1± 0,7	27,8 ± 0,6
Mass of 1000 seeds, g	2,1	1,8
Germination of seeds in laboratory conditions, %	68,2±1,3	53,2± 1,2
Gross seed crop, kg/ga	160,7 ± 3,2	93,6 ± 4,8

Laboratory germination tests also confirmed the superiority of the Karnab desert for establishing seed production fields. The germination rate of seeds grown in the Karnab desert was 68%, while the germination rate of seeds grown in the Nurata foothills was only 53%. Furthermore, the seed yield of this variety in the Karnab desert reached 161 kg/ha, compared to 93 kg/ha in the Nurata foothills.

CONCLUSION

Based on the research findings, it is advisable to identify desert and semi-desert areas suitable for establishing seed production fields of desert forage plant varieties that ensure high-quality and abundant seed yields. This is because there are no universal varieties that consistently produce high-quality and abundant seed yields across all desert regions.

It was determined that the "Otavniy" variety of sainfoin is optimally suited for seed production in the Karnab desert's soil and climatic conditions. The quality indicators of seeds grown in this region were significantly superior to those grown in the Nurata foothills.

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