Methods of increasing the productivity of desert pasture soils

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Abstract. Expanding on the initial text, integrating agrotechnical measures with ecological and biotechnological strategies is crucial for the sustainable management of desert pasture soils. Among these strategies, the use of mycorrhizal fungi and beneficial bacteria to enhance soil fertility and plant growth offers a promising avenue. These microorganisms improve nutrient uptake by plants, increase water retention in soil, and contribute to the stabilization of soil structure, thereby mitigating the adverse effects of soil salinity and aridity. Furthermore, the application of organic amendments, such as compost and biochar, can significantly improve soil organic matter content, enhancing soil physical properties and increasing its capacity to support microbial life. In addition to biological approaches, adopting water-saving irrigation technologies like drip or subsurface irrigation systems can play a pivotal role in the efficient management of scarce water resources in desert areas. These systems minimize water loss through evaporation and runoff, ensuring that water is delivered directly to the plant roots where it is most needed. Another aspect worth considering is the introduction of agroforestry practices in desert pastures. The integration of trees and shrubs with pastoral and crop production systems not only provides shelter and food for livestock but also contributes to soil protection, biodiversity enhancement, and carbon sequestration, further counteracting the process of desertification.

1. Introduction

Effective and rational use of pasture resources, maintenance of soil fertility is becoming one of the most urgent problems. Proper use of irrigated, dry lands and pastures, organization of land reclamation improvement in all spheres of the national economy, especially in agriculture, are among the first-level tasks [1].

In recent years, the area of fertile land has decreased globally, the processes of salinization and desertification have intensified in pastures, and there are many cases of erosion of the fertile layer of the soil under the influence of water and wind erosion [2].

In this context, enhancing the ecological state of pastures with degraded, low-fertility sandy desert soils and cultivating nutrient-rich crops are the main focuses of scientific research [3]. Specifically, it's important to identify the alterations in soil cover brought on by the deterioration process in pastures with sandy desert soils and to mitigate adverse impacts on soils through research on phytoindicators of desert pasture degradation [4]. Special emphasis is given to the deployment of technologies to stop pasture deterioration by planting promising kinds of desert-nutritious plants, taking into consideration the characteristics of sandy desert soils [5-7].

There are 21.1 million hectares of pastures (46.5%) in Uzbekistan, and for 35-40 years, the number and size of pasture plants has decreased, and degraded areas have increased [8]. In this regard, in Uzbekistan, extensive measures are being taken to develop desert pasture livestock by introducing agrotechnologies aimed at preserving and increasing the productivity of degraded desert pasture soils, preventing degradation of desert pastures, and certain results are being achieved. Therefore, it is important to develop proposals and recommendations aimed at improving the condition of existing pastures in the further development of Uzbekistan's agriculture.

The majority of Uzbekistan's livestock feed comes from natural desert pastures, giving them year-round access to these areas. Nevertheless, natural desert pastures in their existing state are unsuitable for the quick expansion of cattle rearing. The productivity of dry mass does not surpass 1.5–3.0 tons/ha due to the low productivity of natural desert pastures. Furthermore, the productivity of naturally occurring desert pastures is contingent upon meteorological

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circumstances; hence, the productivity exhibits significant fluctuations both annually and seasonally. Natural desert pasture productivity can grow up to two times in years of high precipitation compared to an ordinary year; in contrast, it can decline to 1-0.5 tons/ha in years of drought. Every 10 years, three years with a high yield, four years with an average yield, and three years with a poor yield are repeated, according to data gathered from long-term observations [3, 6].

As far as we are aware, one of the most significant problems of both scientific and practical significance is the creation of a complex of agrotechnological measures and their sensible use in a particular ecological setting, such as salt soils or natural desert pastures. In this sense, concerns including germination, growth, normal seed development, nutritional mass accumulation, and seed formation were taken into consideration when developing agro-technological methods for the production of desert-producing nutritious crops [4].

When implementing agrotechnical measures, it is imperative to avert the deterioration of sandy desert soils and enhance natural pastures. In this instance, it aids in ensuring that seeds of various desert-nutritious plants germinate, thrive, and accumulate a high nutritional content in sandy desert soils. The ecological and biological appropriateness, purity, and fertility features of plant seeds are the factors that govern field selection, tillage and placement of desert-nutritious crops, ideal planting periods, and seed consumption standards [9, 10].

Extensive scientific research works on the study of morphological indicators, agrophysical and agrochemical properties of pasture soils, microbiological activity, land reclamation have been carried out by a number of people. However, in order to improve the condition of degraded desert pastures and increase their productivity, scientific researches related to the development of effective agrotechnical measures (i.e. planting rate, duration, scheme and feeding rates) for the cultivation of promising varieties of desert nutritious plants suitable for soil and climatic conditions have not been carried out enough.

2. Materials and Methods

The study was conducted in “Kizilcha” farm (Nurota district, Navoiy province, Uzbekistan), a desert region characterized by its arid climate and sandy soil composition. Soil samples were collected from multiple sites within this region to ensure a comprehensive analysis. Each site was selected based on its representative soil type and vegetation cover, common to desert pasture areas. The samples were collected from the top 15 cm of the soil profile, where most root activity occurs in pasture plants, using a soil auger. The collected samples were air-dried, ground, and sieved through a 2 mm mesh to remove coarse fragments and organic debris.

A controlled environment experiment was set up to simulate desert pasture conditions. The experiment employed a randomized complete block design (RCBD) with four treatments and five replicates per treatment. Organic amendments were applied by evenly spreading the composted material over the soil surface and incorporating it into the top 15 cm of soil using a rotary tiller. Inorganic fertilizers were applied according to the manufacturer's recommendations and thoroughly mixed with the soil. Hydrogels were pre-moistened according to the manufacturer's instructions before being mixed with the soil to ensure uniform distribution. Seeds of a commonly found desert pasture species, were sown at a density reflective of natural conditions. The experimental plots were irrigated immediately after sowing to facilitate germination and then maintained at moisture levels typical of desert pastures using a drip irrigation system.

3. Results and Discussion

In order to develop perennial nutritious seed nurseries that can thrive in the conditions of sandy desert soil, a variety of perennial nutritious crop kinds were planted in the Nurota region of Navoi province over the course of the research. Timely and high-quality agrotechnical measures play a crucial role in the implementation of these measures, taking into account the region's natural and climatic conditions, the unique characteristics of desert-nutrient plants in specific desert regions, and the features of pasture soils.

It is known that the physical properties of soils are one of the most important criteria for evaluating their productivity or degree of degradation along with expressing the nature of the processes taking place in the soil. It is known that the study of the general physical properties of the soil is of great importance in the development of the scientific foundations of highly efficient and rational agriculture, because the physical properties of the soil have a great impact on soil fertility, the occurrence of degradation processes, the progress of biological processes and obtaining a high yield from agricultural crops.

This is especially important in the development and appropriate application of agro-technologies for the cultivation of perennial nutritious crops in order to prevent the degradation of pastures in pasture areas. Therefore, some species or groups of plants can also serve as protection for the ground cover of desert grasslands (Table 1).

According to the results of the conducted research, the volume weight of the studied soils changed from 1.32 g/cm^3 to 1.53 g/cm^3 along the upper soil profile. The relative weight is 2.62-2.69 g/cm^3, correspondingly, the total porosity fluctuates around 41.6% to 50.3%.

Table 1. General physical properties of sandy desert soils

Section number and soil type	Layer depth, cm	Volumetric mass, g/cm^3	Comparative weight, g/cm^3	Porosity, %
Section #26 Sandy desert	0-20	1.41	2.62	46.1
	20-50	1.42	2.65	46.4
	50-80	1.42	2.66	46.6
	80-120	1.56	2.68	41.7
Section #28 Sandy desert	0-8	1.32	2.66	50.3
	8-30	1.52	2.69	43.4
	30-90	1.42	2.67	46.8
	90-115	1.38	2.65	47.9
Section #40 Sandy desert	0-30	1.39	2.68	48.1
	30-52	1.52	2.66	42.5
	52-120	1.53	2.62	41.6

It is observed that it is deflated and varies depending on the specificity of soil formation processes. Sandy desert soils are characterized by high specific gravity and low porosity due to the fact that they consist of various large sand particles.

This causes unfavorable food, water and air conditions for the development of plants and microorganisms in these soils. Also, the research shows that the chemical and agrochemical properties of the soils of the studied area were drastically changed as a result of the deflation processes, and as a result, important parameters such as the amount of humus, nitrogen, phosphorus and potassium in the soil decreased (Table 2).

When planting different desert food crops, the correct selection of the area is important. First of all, degraded and endangered areas can be selected and planted in areas where the vegetation cover is sparse, in which timely and high-quality tillage of the soil is important.

Plowing at a depth of 20–22 cm was done in February to conduct the trials, following rains that saturated the soil tillage layer. The process of fertilization was completed prior to seed planting.

Factors representing the dryness of the climate of the desert region - high air temperature, dryness of the air, very low amount of precipitation, very fast drying of the surface layer of the soil, sharp changes in the climate in the spring season require the correct selection of the optimal dates for planting seeds. Appropriate amounts of grass are harvested from the seeds sown at appropriate times. The best time to plant desert plants is from December to February.

Table 2. Agrochemical properties of sandy desert soils

Layer depth, cm	Humus, %	Total, %			$N\text{-}NO_3$	Reactive, mg/kg		CO_2, %	SO_4, %
		N	P	K	mg/kg	P_2O_5	K_2O		
Section #26									
0-12	0.85	0.072	0.109	1.50	5.7	39.8	260	5.79	0.075
12-50	0.47	0.056	0.096	1.20	4.1	20.2	156	6.54	0.089
50-80	0.26	0.048	0.060	0.82	3.1	14.9	106	6.66	0.091
80-120	0.19	0.022	0.064	0.38	6.3	3.5	179	8.16	0.088
Section #28									
0-8	0.87	0.062	0.105	1.20	4.5	37.2	294	5.60	0.053
8-30	0.53	0.042	0.098	0.92	3.6	11.5	180	6.40	0.046
30-90	0.24	0.024	0.062	0.85	3.1	14.9	150	7.49	0.072
90-115	0.18	0.023	0.043	0.62	3.8	8.4	100	8.54	0.111
Section #40									
0-14	0.65	0.045	0.100	0.48	10.2	22.8	409	6.60	0.088
14-52	0.42	0.030	0.096	0.45	8.9	18.5	337	7.59	0.082
52-120	0.31	0.026	0.084	0.45	7.6	5.6	323	8.80	0.071

Seeds of shrubs and semi-shrubs are planted at a depth of 1.5 - 2.0 cm. The norm of planting seeds of one type of crops, keureuk and saxowul - 6-8 kg/ha, male grass (jitnyak) 5-6 kg/ha and other desert plants were also planted in accordance with the regulations. After the germination of seedlings, the germination of seeds in the field, the number of seedlings and the dynamics of retention, the development of adult plants and the formation of the root system were determined.

The vitality of seedlings and adult plants is measured twice for desert food crops (saksovul, izen). After the summer flowering phase, in the spring when the seedlings are starting to appear. For every variety of plant, measurements are taken of the plant's height and the length of its shoots in the first year of growth. The stems and leaves of the chosen samples are identified once they have dried.

In Kyzylkum's sandy desert, drought-tolerant plants were initially planted straight on natural pastures. To obtain high-quality seeds of food plants, a sophisticated process has been created. Following fertilization and plowing, hung and mounted seed drills were used to plant in order to prepare the fields for the following year's desert fodder crops (seed plants).

On March 2-3, field experiments on the types of desert nutritious crops were conducted on a plot with a length of 10 meters and a width of 140 meters. Phenological observation data showed that among planted desert crops, izen had the highest fertility and the greatest quantity of perfect seeds, ranging from 4,050 to 8,450,000 pieces/ha (Table 3).

Table 3. Phenological observations on the growth and development of desert forage plants (2022)

Study area	Plant type	Average height of the plant, cm		Average root length, cm		Average plant density (‘000/ha)	
		May 7-10	June 12-13	May 7-10	June 12-13	May 7-10	June 12-13
Nurota district	Izen	1.14	2.50	12.40	22.20	8450	4050
	Saxaul	4.05	6.00	19.20	21.20	2800	1650

It is worth noting that the importance of nutritious crops in the management of desert pastures is also evidenced by the fact that their flexibility is much higher when they are used in combination with other species than when they are used alone.

Autumn plowing was carried out in December in order to plant desert fodder plants. Before planting, saxes were planted at the rate of 3-4 kg/ha of izen seeds and male grass at the rate of 4 kg/ha of izen seeds for the arid zone with a row spacing of 70 cm using a combination seeder.

Field experiments were conducted on sowing saxowul, izen, and male grass seeds with 25 g seeding rate in the row spacing of 70 cm, each width and length of 10 m, with plowing, plowing, and harrowing in three replicates.

Also, some experiments were conducted in the field area of Nurota district on unplowed background. Sowing was carried out when the purity of the seeds of ysen was 48.3% and the germination in the laboratory was 51.0%, and the purity of the saxowul seeds was 44.0% and the germination was 40.2% in the laboratory. Single buds appeared on April 29-30 (2022). By May 29-30 (2022), the height of the plants, the number of plants and the length of the root system were determined (Figure 1).

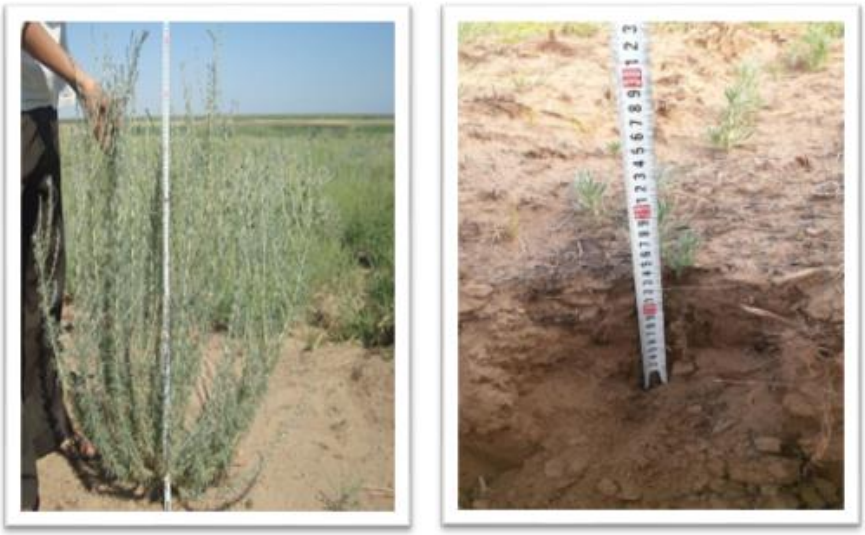

Fig. 1. Phenological observations

4. Conclusions

In conclusion, it was noted that in the summer, the average height of the plants, the average length of the roots, the average thickness of the plant, and the total number of plants were higher in the variants than in the spring. This is because izen seeds are biologically characterized by high viability and germination in favorable conditions.

Generally speaking, intricate steps must be put in place to stop the process of soil degradation, and agrotechnical measures must be developed with the goal of restoring, maintaining, boosting, and safeguarding the productivity of sandy desert soils. The effective methods, including cultivating perennial nutritious desert plant species that are resistant to drought and saline soil conditions, propagating their seeds, and increasing the amount of these crops planted

in desert areas, are essential to restore the flora of degraded areas and stop wind erosion and desertification , which in turn provide a scientific foundation for preserving, boosting, and safeguarding the fertility of pasture soils as well as for the economical and sensible use of land on farms that specialize in raising cattle for desert pasture.

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