Journal of Plant Biota

Research Article
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Changes in the amount of photosynthetic pigments in the native *Artemisia diffusa* in the semi-desert rangelands of Uzbekistan under the influence of different sheep grazing intensities and different seasons

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Abstract

Rangelands, as critical components of terrestrial ecosystems, play a pivotal role in supporting biodiversity and providing essential ecosystem services. The relationship between grazing activities and vegetation dynamics is a topic of ongoing research, with a focus on understanding how these interactions influence key physiological processes in dominant plant species. This study investigated the changes in photosynthetic pigments of rangeland Artemisia diffusa under varying sheep grazing intensities. Four different grazing intensities were imposed: initial, low, medium, and high. Sampling took place at regular intervals over the 2021-2022 year spring sezon to assess the temporal dynamics of photosynthetic pigments. The study focused on measuring changes in the concentration of key photosynthetic pigments, including chlorophyll-a, chlorophyll-b, and carotenoids, in selected Artemisia diffusa species over the grazing period. Our results showed a clear correlation between sheep grazing intensity and changes in photosynthetic pigment concentration. In general, Artemisia diffusa at initial and low intensities showed lower levels of chlorophyll a and b than those at moderate and high intensities. Carotenoid concentrations were also observed to change significantly and increase significantly at high sheep grazing intensities.

Keywords: *rangelands, Karnabchul semi-desert, grazing, Artemisia diffusa, photosynthetic pigments*

Introduction

Rangelands, characterized by vast expanses of natural grasses and shrubs, play a crucial role in global ecosystems [1]. The delicate balance between vegetation dynamics and herbivore activities, such as sheep grazing, is essential for maintaining the health and productivity of these ecosystems [2].

In Uzbekistan, rangelands are mainly important in providing livestock with natural fodder [3]. Rangelands make up about 50% of the total land area of Uzbekistan, more than 21 million hectares [4]. Rangelands degradation is a serious socio-economic and environmental problem in Central Asia and Uzbekistan [5]. According to the international document of the United Nations, soil erosion under the influence of various anthropogenic factors has been observed in approximately 52 million km^2 of the world [6] The main cause of this phenomenon is overgrazing of pastures by livestock [7].

Overgrazing of rangelands threatens the preservation of ecosystems by trampling vegetation [8]. It increases the influence of pasture plants on soil structure indirectly, which leads to the acceleration of desertification processes [9]. Different levels of grazing lead to negative changes in the structure, physico-chemical, moisture, and organic matter of rangeland soils [10]. In the studies conducted by several foreign scientists, it was mentioned in their studies that different levels of grazing have negative and positive effects on the physiological development of rangeland plants [11]. A positive effect is that grazing is important for removing dead tissue from plant organs [12]. It has a positive effect only at moderate levels of grazing [13]. It is manifested by the activation of physiological processes in young parts of plants [14]. However, a significant difference is observed with the increase in the level of grazing in the rangeland [15]. Grazing before restoring the main photosynthetic organs leads to the disruption of physiological processes [16].

The low, medium, and heavy intensity of livestock grazing significantly affects the morphological and physiological characteristics of plants, especially their photosynthetic capacity [17]. This is evident in changes in the amount of photosynthetic pigments [18]. Livestock grazing stress in plants is a result of eating morphological parts of plants in rangelands that are highly grazed [19] Various changes occur in response to the effects of stress on plants caused by regular grazing of livestock [20]. He pointed out that the observation of physiological stress in plants under the influence of different grazing was observed especially in plants from rangelands with a high level of grazing [21].

Understanding the impact of different sheep grazing intensities on the photosynthetic pigments of dominant rangeland plants is

30 November 2023: Received | 30 January 2024: Revised | 15 March 2024: Accepted | 21 March 2024: Available Online

Citation: Shuhrat Valiyev, Toshpulot Rajabov, Flora Kabulova, Alisher Khujanov, Sirojiddin Urokov (2024). Changes in the amount of photosynthetic pigments in the native *Artemisia diffusa* in the semi-desert rangelands of Uzbekistan under the influence of different sheep grazing intensities and different seasons. *Journal of Plant Biota.* **DOI: https://doi.org/10.51470/JPB.2024.3.1.24**

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essential for sustainable rangeland management [22]. This study aims to investigate how varying levels of sheep grazing influence the abundance and composition of photosynthetic pigments in key plant species within rangeland ecosystems. By elucidating these dynamics, we can gain insights into the ecological consequences of grazing practices, informing land management strategies and promoting the long-term health of rangeland ecosystems.

Materials and methods

The research was conducted in the natural rangelands of the Karnabchul semi-desert located in the southern of Uzbekistan during 2021-2022. The total area of the Karnabchol semi-desert is 500 thousand hectares and consists of two types of soil conditions (Fig. 1).

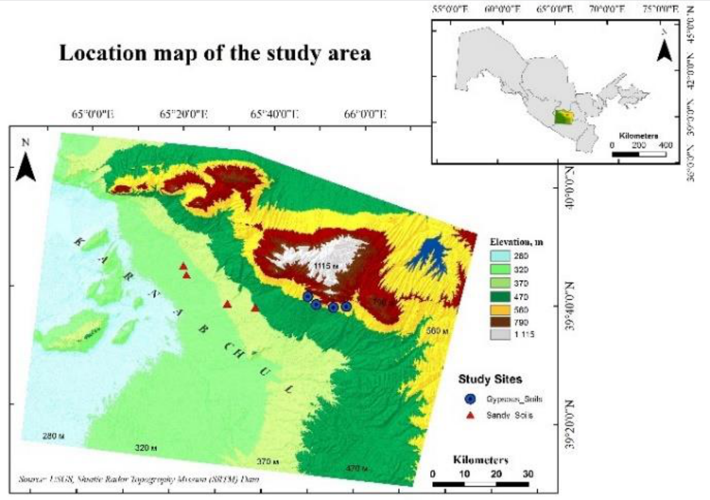

Figure 1. Location and elevation indicators of study sites of Karnabchul semi-desert of Uzbekistan.

The climate of Karnabchul semi-desert, like all the deserts of Central Asia, is characterized by dryness and sharp continentality. It stretches 120 km from west to east the average width is 40-50 km, the average height is 300 m (350 m in the central part, 450 m in the eastern part). The long-term average annual air temperature is +17.1^{0}C. The hottest air temperature is observed in June-July, 40-47^{0}C, constitutes [23]. The coldest temperatures are observed in December-February, sometimes reaching minus 20-30 ^{0}C (Fig 2).

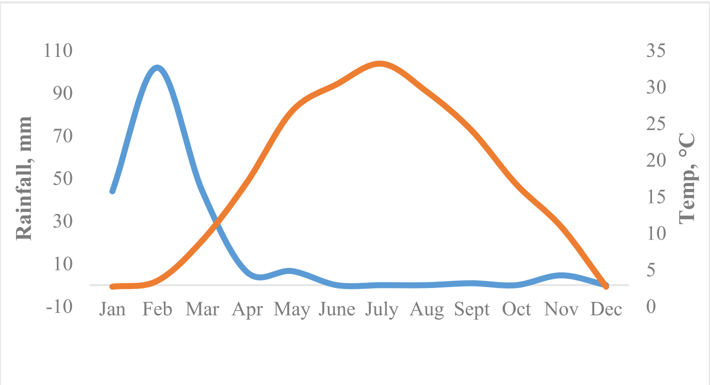

Figure 2. Rainfall and temperature of the studied area, the blue line is rainfall, and the orange line is temperature.

A total of 8 rangelands were selected for research according to the level of sheep grazing (initial, low, middle, and high).

According to the soil conditions of these areas, it belongs to 4 types of grey-brown soils with gypseouse and 4 types of light gray soils.

To determine the amount of photosynthetic pigments, pigment solutions were prepared from one-year assimilatory branches and leaves of dominant plants. Chlorophyll a at 663 nm, chlorophyll b at 645 nm, and carotenoidsin mg/l were determined on an EMC-spectrophotometer (SF) (www.ems-lab.de) [24], [25].

Result and discussion

The low p-value (<0.001) suggests that there is a significant difference in pigment content among different grazing intensities. A high F-value indicates a significant difference (Table 1)

Table 1: ANOVA analysis results of Artemisia diffusa pigment content in two different soil types

ANOVA	F- value	P- value
Grazing intensities	56,4	<0,001
Soil type	58,3	<0,001
Grazing intensities: Soil type	7,8	<0,001

Similar to grazing intensities, the low p-value (<0.001) indicates a significant difference in pigment content among different soil types. The interaction term between grazing intensities and soil type also has a low p-value (<0.001), suggesting that the combined effect of grazing intensities and soil type significantly influences the pigment content of *Artemisia diffusa*.

All three factors grazing intensities, soil type, and their interaction—have statistically significant effects on the pigment content of *Artemisia diffusa*.Under conditions of (IG) and (LG) intensities, the amount of chlorophyll a in *Artemisia diffusa* was 2.4 mg/l to 2.1 mg/l. In the conditions of (MG) and (HG), it was observed that it significantly increased from 2.9 mg/l to 3.7 mg/l (Fig. 1).

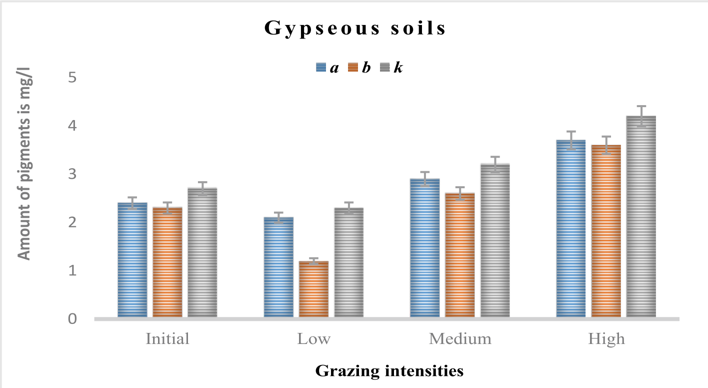

Figure-1. Photosynthetic pigment content of Artemisia diffusa under different grazing intensities under gypseous soil conditions.

An increase in the amount of carotenoids was observed in Artemisia diffusa at all grazing intensities in the gypseous soil rangeland.

The intensity of grazing intensities on the amount of pigments of *Artemisia diffusa* had a significant effect on rangeland conditions with sandy soil (Table 1).

In rangelands with sandy soil, the amount of *Artemisia diffusa* chlorophyll a was not observed to increase uniformly in the grazing intensities, but the amount of carotenoids was observed to be high in all grazing intensities Fig. 2.

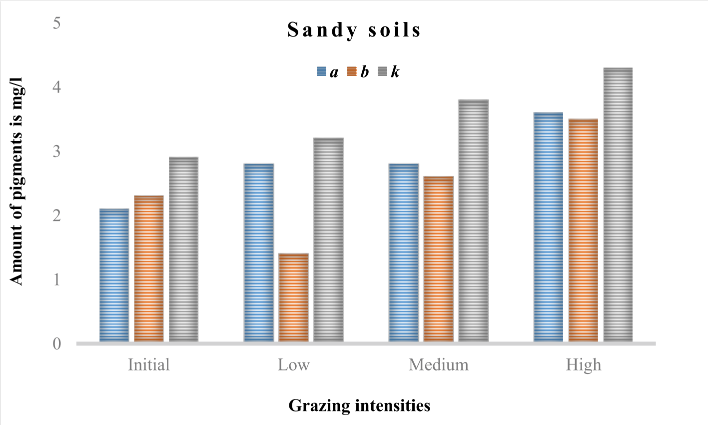

Figure-2. Amount of photosynthetic pigments at different grazing intensities of Artemisia diffusa under sandy soil conditions

It was observed that the amount of photosynthetic pigments of *Artemisia diffusa* under different grazing conditions decreases from spring to autumn, according to the results of our seasonal comparison (Table 2).

Table-2. Changes in seasonal photosynthetic pigment content of Artemisia diffusa in rangelands with gypseous soils.

Seasons	*a*	*b*	*k*
	Amount of pigments is mg/l		
Spring	3,6±0,12	3,7±0,61	4,2±0,87
Summer	2,7±0,78	1,5±0,24	3,4±0,94
Autumn	2,1±0,62	1,1±0,59	2,7±0,78

In the summer season, the amount of photosynthetic pigments of *Artemisia diffusa* was significantly different compared to the spring season, and the amount of chlorophyll per 1 g of green mass was equal to 2.7 mg/l. The amount of chlorophyll *b* was significantly reduced compared to the spring season and reached 1.5 mg/l. It was found that the amount of carotenoids was significantly higher compared to chlorophyll *a* and *b*, but decreased compared to the spring season.
According to the analysis results, the amount of photosynthetic pigments of *Artemisia diffusa* in the autumn season significantly decreased compared to the spring and summer seasons. It was found that the amount of chlorophyll *a* decreased to 2.1 mg/l, and the amount of chlorophyll *b* also decreased to 1.1 mg/l. It was observed in our experiments that the amount of carotenoids was significantly reduced to 2.7 mg/l.
It was observed that the amount of seasonal photosynthetic pigments of *Artemisia diffusa* in sandy soils decreases from spring to autumn, just like in gypseous soils (Table 3).

Table-3. Seasonal changes in the amount of photosynthetic pigments of Artemisia diffusa in sandy soil rangelands.

Seasons	*a*	*b*	*k*
	Amount of pigments is mg/l		
Spring	3,4±0,42	3,1±0,64	3,9±0,48
Summer	2,6±0,74	1,9±0,72	3,7±0,65
Autumn	1,9±0,59	1,8±0,48	3,3±0,83

Regular consumption of leaves and young shoots of *Artemisia diffusa* by sheep leads to increased assimilation capacity. This accelerates the assimilation of many nutrients from the soil. The assimilation of nutrients in large quantities reduces the fertility of the soil and accelerates the degradation process [26]. Therefore, in both soil conditions, the degradation process increased with increasing grazing stress [27]. In rangelands with intensive livestock grazing, the number of senotically large bushes of *Artemisia diffusa* under stress is high, but in both soil conditions, the root system is weakly developed and does not penetrate deep into the soil. The abundance of small *Artemisia diffusa* bushes in pastures with high livestock grazing stress has led to a decrease in rangeland biomass [28]. On the contrary, the root system has developed compared to the areas with low nutritional stress. This requires a lot of nutrients to be absorbed from the soil [29].
Changes in the amount of photosynthetic pigments of *Artemisia diffusa* in response to livestock feeding stress. A significant difference was observed in the amount of chlorophyll *a*, *b*, and carotenoids with increasing feeding stress compared to the areas under low feeding stress. This difference was especially evident in the ratio of chlorophyll *a* and *b* to carotenoids. The high content of carotenoids indicates the physiological adaptability of *Artemisia diffusa* to nutritional stress. *Artemisia diffusa* bushes, whose leaves and twigs are eaten by livestock, use carotenoids as a unique defense against excessive sunlight damage.
Seasonal changes in the amount of photosynthetic pigments in grasslands with gypsum soil in the spring season is a period of active growth and biomass accumulation of *Artemisia diffusa* in terms of vegetation.

Conclusion

In conclusion, our study investigated the impact of varying sheep grazing intensities and different seasons on the levels of photosynthetic pigments in native *Artemisia diffusa* within the semi-desert rangelands of Uzbekistan. These findings contribute to the growing body of knowledge on the ecophysiology of *Artemisia diffusa* in semi-desert rangelands and provide valuable insights for sustainable rangeland management practices. As we navigate the delicate balance between livestock grazing and ecosystem conservation, it becomes imperative to consider the intricate dynamics influencing the photosynthetic pigments in native vegetation, ultimately shaping the resilience of these ecosystems in the face of anthropogenic pressures.
This study opens avenues for further research, emphasizing the importance of long-term monitoring to elucidate effects of grazing intensities and seasonal variations on the photosynthetic pigments and overall health of *Artemisia diffusa* in Uzbekistan's semi-desert rangelands.

Acknowledgments

The authors would like to thank the Department of Plant Physiology and Microbiology, Institute of Biochemistry, Samarkand State University named after Sharof Rashidov, for using the laboratory equipment

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