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Changes of photosynthetic pigments of *Artemisia diffusa* under the influence of grazing stress of livestock grazing in Karnabchul semi-desert, Uzbekistan

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Abstract

On the transformed natural rangelands of Karnabchul desert, the natural *Artemisia diffusa* studied four different grazing intensities the change in the amount of photosynthetic pigments (chlorophyll *a*, chlorophyll *b*, carotenoids). It was found that the amount of *A. diffusa* pigments also increased with increasing stress levels in livestock grazing. In general, different grazing intensities had a different impact on the morphological and physiological traits of plants, especially their photosynthetic pigments.

Keywords

photosynthetic pigments, phytocenotic indicators, chlorophyll *a*, chlorophyll *b*, carotenoids.

Introduction

Rangeland ecosystems play an important role in biodiversity conservation and food security among other natural ecosystems of Uzbekistan (1). In recent years, overgrazing in natural rangeland has consistently reduced the productivity of vegetation cover, as well as damaged the structure and functions of the rangeland ecosystem (2, 3). Dominant forage plant species make a significant contribution to the productivity of rangeland ecosystems (4, 5). Therefore, natural food plants play an important role in resisting the effects of anthropogenic factors and maintaining stability (6).

Therefore, we need to be aware of the negative changes in the impact of livestock grazing on the dominant species of rangeland (7). Livestock grazing is an important element of ecosystem regulation because it can affect important ecosystem functions such as nutrients (8). Overgrazing can threaten the conservation of ecosystems through excessive defoliation or trampling of vegetation. It also indirectly increases the effect on soil structure (8, 9). This leads to the acceleration of desertification processes (10). Livestock grazing produces more new twigs and leaves to restore the photosynthetic ability of plants as a result of consuming green leaves and twigs of plants cause an increase in physiological processes (11). In particular, changes in the amount of photosynthetic pigments are observed (12). Currently, the stress of livestock grazing in semi-desert, rangeland ecosystems has led to changes in the physiological parameters (amount of photosynthetic pigments) of palatable *Artemsia diffusa* (13). Because damage to plants increases with increasing grazing intensity, plant photosynthetic properties are also likely to change (3, 14).

However, we still don't fully understand the physiological changes that occur under different grazing intensities. Overall, the available evidence suggests that the plant's photosynthetic capacity is affected by the structural and physiological responses to grazing (15). Unfortunately, such studies have not been sufficiently conducted on plants in semi-desert natural rangelands (2). Given the current situation with unsystematic and unregulated livestock grazing this problem is one of the most pressing today (1, 2, 6).

Therefore, much attention is currently being paid to research on livestock feeding and its consequences. Such developments have not only scientific but also great practical significance. Information about the importance of some plants in the desert regions of Uzbekistan is recorded in the works of local and foreign authors (16). Knowing the development trends of rangeland plants and their resistance to anthropogenic influences, it is possible to regulate livestock grazing and thus keep rangeland ecosystems in a highly productive state (21, 22). The aim of this study was to determine the changes in the amount of photosynthetic pigments under different livestock grazing conditions of *A. diffusa.*

Materials and Methods

The research was conducted in the spring in the Karnabchul semi-desert area of the Nurabad district of the Samarkand region. The climate of the Karnabchul semi-desert is characterized by the arid continental climate of all deserts of Central Asia (1). The average annual temperature is + 17.1 ^{0}C. The average temperature is 40-47 ^{0}C in June-July (2, 6, 17). The lowest temperature is observed in December and February, sometimes up to minus 20-30 ^{0}C (1, 17). 8 sites with different levels of degradation were selected in the study area (18).

Two types of soil conditions are 4 gypseous and 4 sandy (6). Studies in selected sites were conducted in April month of 2019-2021 during the period of physiologically active biomass accumulation (leaves) of *A. diffuse* plants. The determination of phytocenosis parameters was carried out using traditional geobotanic research methods (18).

A total of 72 bushes of *A. diffuse* (big, medium, small) plants were sampled from each study area according to rangeland stress level (initial, low, medium, high) (18). Determination of leaf pigments was carried out by the method of T.N Godnev and H.K. Lichtenthalers (12, 19, 20). The obtained samples were dried in a desiccator at 65 ^{0}C and 96% ethanol-soluble pigment solutions were prepared from 1 g of dry annual assimilation twigs and leaves. The solutions were determined in mg/l at a wavelength of chlorophyll *a* 663 nm, chlorophyll *b* 645 nm and carotenoids 470 nm on the EMC spectrophotometer (SF) (www.emc-lab.de).

Results and discussion

The phytocenotic characteristics of *A. diffusa* biomass were significantly different among the four grazing stresses. In areas with initial livestock grazing intensity, *A. diffuse* biomass was dominant with high biomass. The biomass of *A. diffusa* was 815 kg per hectare at the initial grazing intensity in pastures with gypseous soil and the biomass in sandy rangelands was 686.7 kg on average (Fig. 1).

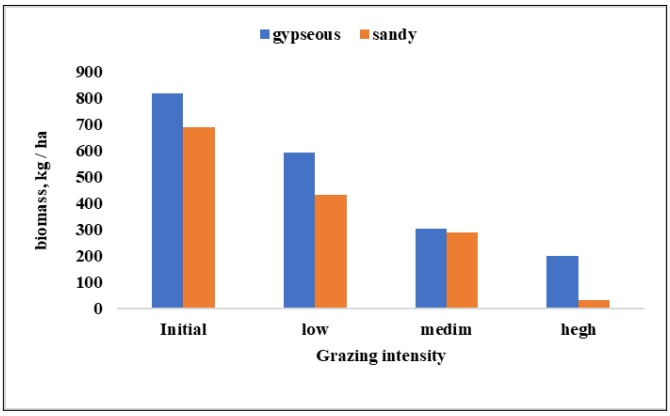

Fig. 1. Changes in biomass in *Artemisia diffusa* gypseous and sandy soil conditions.

Under the stress condition of low grazing intensity, 589.7 kg of biomass was accumulated per hectare in the gypseous rangelands. In our sandy soil conditions, rangelands with slightly *A. diffusa* less biomass was accumulated, amounting to 432.1 kg. Our results showed that the medium grazing intensity of *A.* diffusa varied from 303.9 kg to 289.1 kg on 2 types of gypseous and sandy soils. Gypseous soil in our rangelands with high grazing intensity biomass 197.7 kg of *A. diffusa* biomass, while sandy areas had a significantly decrease biomass of 30.5 kg. Changes in biomass and were accelerated in sandy rangelands.

According to the data of our research, the projective cover accounted for 37.8% of the initial intensity of grazing in gypseous rangelands, and 32.3% in sandy rangelands. Our results showed that the projective cover of *A. diffusa* was 36% in gypseous rangelands and 30% in sandy rangelands at low grazing intensity (Fig. 2).

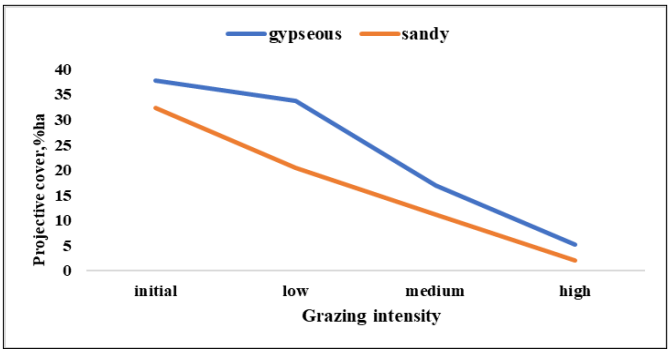

Fig. 2. *Artemisia diffusa* changes in projective cover in gypseous and sandy soil conditions.

In rangelands with medium intensity of livestock grazing, 16.9% in gypseous soils and 11.1% in sandy rangelands.

Especially where grazing stress is high during our experiments, it was found that the projective cover of *A. diffusa* was 5.3% per ha in our gypseous soil rangelands and it decreased sharply to 2.1% per ha in sandy rangelands.

The density of *A. diffusa* at different grazing intensities was 41400 per ha in the gypseous research area with initial grazing intensity and 31266 per ha in our sandy rangelands.

At a low grazing intensity, *A. diffuse* was a density of 36200 per ha in rangelands with gypseous soil and 26243 in rangelands with sandy soil (Fig. 3).

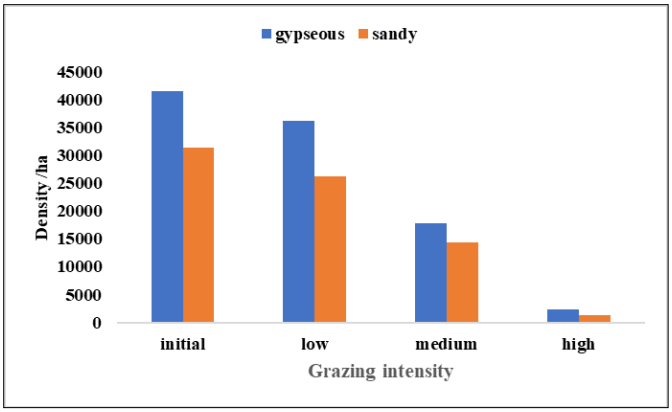

Fig. 3. Changes in the number of density in *Artemisia diffusa* gypseous and sandy soil conditions.

When we analysed our results in 2 different soil conditions in our research area, it was determined that the medium grazing intensity was 17733 in gypseous rangelands and 14400 in sandy rangelands.

In our research rangelands with high grazing intensity, the density of *A. diffusa* per hectare was 2400 per ha in gypseous soil conditions, while it was determined during our experiments that 1253 densities per ha were in our sandy rangelands.

In gypseous soil conditions where the level of grazing stress is initial, the average amount of chlorophyll *a* in 1 g of the dry mass of *A. diffusa* in rangeland is 2.4 mg/l, chlorophyll *b* 2.3 mg/l, the amount of carotenoids is 1 gr was found to be 2.7 mg/l per green mass (Fig. 4).

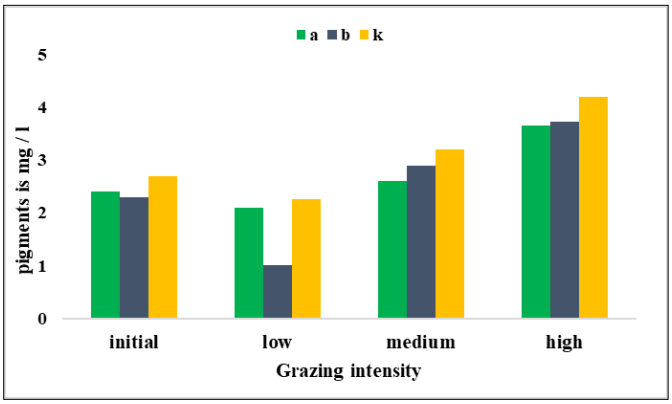

Fig. 4. Amount of photosynthetic pigments in the leaf period of *Artemisia diffusa* (in gypseous soil conditions).

Chlorophyll *a* 2.01 mg/l, chlorophyll *b* 2.35 mg/l and carotenoids 2.92 mg/l were found in areas with initial grazing stress. Morpho physiologically, inedible branches of *A. diffusa* were also preserved in these areas. When the amount of photosynthetic pigments were determined in areas with low levels of stress relative to anthropogenic factors and the level of livestock grazing, chlorophyll *a* was 2.83 mg/l, chlorophyll *b* was 1.38 mg/l and carotenoids were 3.23 mg/l.

When the amount of photosynthetic pigments and grazing stress was calculated in the average study area, chlorophyll *a* was 2.89 mg/l, chlorophyll *b* was 2.46 mg/l and carotenoids were 3.85 mg / l.

In general, the study found that the amount of photosynthetic pigments in plants was higher in the affected intense grazing than in the areas with a low level of grazing. It has been observed that the amount of photosynthetic pigments are even higher in overgrazed areas (Fig. 5).

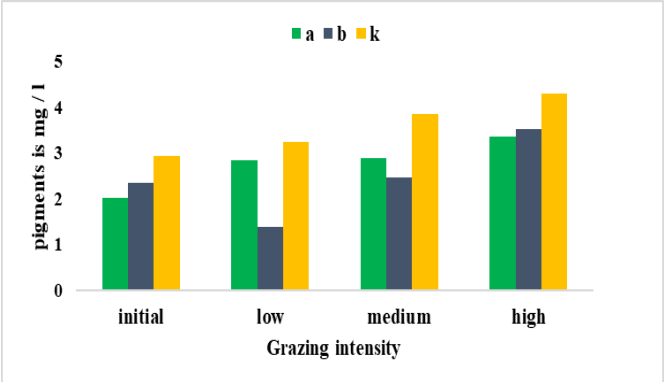

Fig. 5. The amount of photosynthetic pigments during the leafing period of *Artemisia diffusa* (in sandy soil conditions).

Chlorophyll *a* 3.36 mg/l, chlorophyll *b* 3.52 mg/l and carotenoids increased to 4.3 mg/l.

Regular consumption of *A. diffusa* leaves and young twigs by livestock grazing leads to an increase in assimilation capacity (3). These speed up the absorption of many nutrients from the soil. Absorption of large amounts of nutrients reduces soil fertility and accelerates the process of degradation (21). Therefore, in both soil conditions, the degradation process also intensified as the grazing stress increased (13). In rangeland with low stress of grazing, the number of genetically large shoots of *A. diffusa* is high, but in both soil conditions, the root system is poorly developed and does not penetrate deep into the soil (2). The changes in biomass projective cover and density in gypseous and sandy rangelands decreased with increasing grazing intensity. Changes in rangeland phylogenetic indicators depending on the level of livestock grazing affect quality indicators (22).

However, when the amount of photosynthetic pigments were analysed, conversely, the amount of photosynthetic pigments also increased as anthropogenic factors and livestock grazing rates increased. As these responses show, plants that face different grazing stress may exhibit different responses and different protection strategies (23). Because damage to plants increases with increasing grazing intensity, plant photosynthetic pigment properties are also likely to change (24, 25). In general, the absorption and utilization of solar energy by plants change in response to grazing (26).

The high prevalence of small *A. diffusa* in high rangeland areas due to livestock grazing stress has led to a decrease in rangeland biomass. Significant differences were observed with increasing amounts of chlorophyll *a*, *b* and carotenoids relative to areas under low grazing stress. This difference was particularly evident in the ratio of

chlorophyll *a* and *b* to carotenoid. The high content of carotenoids in response to the grazing stress of *A. diffusa* is associated with physiological adaptation, and it is known during our experiments that it was high in all grazing intensities. High levels of carotenoids indicate that *A. diffusa* is physiologically adaptable to grazing stress. *A. diffusa* with leaves and twigs collected by livestock use carotenoids as a specific means of protection against excessive sun damage (3, 4).

Conclusion

Under the influence of anthropogenic factors, including the regular overgrazing, the phytocenotic parameters of *A. diffusa* changed and its biomass, projective cover and density decreased sharply. As a result, it had a negative impact on the productivity of rangelands. Due to the physiological changes of *A. diffusa* as a result of the overgrazing use of rangeland, an increase in the amount of photosynthetic pigments is observed. The increase in the amount of photosynthetic pigments corresponds to rangelands with a high intensity of livestock grazing.

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Authors contributions

SV and TR contributed to formal data analysis, methodology, writing-original draft, writing review and editing. BA analyzed and recommended the methodology. AS reviewed this manuscript.

Compliance with ethical standards

Conflict of interest: The author declares that there is no conflict of interest associated with this research.

Ethical issues: None.

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