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Plasticity of Leaf Morphological Traits Impacted by Livestock Grazing On Trees in Zagros Semi-Arid Forest

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Abstract: Livestock grazing makes deforming, thorny and twisted branches. The leaf are the main food resources for livestock. We aimed to investigate the leaf morphological characteristics of Zagros forest species under the livestock grazing. Therefore, leaf morphological characteristics of six forest species were investigated in five forest stands in Ilam province. Morphological traits: leaf width, leaf length, petiole length, leaf area, leaf dry weight were measured. The results showed that grazing affects most of the leaf morphological traits. To sum up, the findings showed that tree leaves are more susceptible to grazing stress as the grazing will damage the tree growth and forest regeneration and structure. Therefore, knowing how livestock causes damage in the forest trees will help to lessen the forest destruction and then manage forest better.

Keywords: Livestock grazing; leaf morphological traits; Forest Conservation; structural adaptation; Zagros forest.

1. Introduction

Forests are of the most important natural resources that provide economic, social and environmental benefits and play an important and fundamental role to continue the human and other organisms lives. Zagros forests are the largest forest area in Iran that always have been undergone changes and destruction [1]. One of the destructive influencing factor is livestock grazing. Heavy livestock grazing by compacting and disturbing the soil and reducing water infiltration rate damages plant growth and makes deforming, thorny and twisted branches. Leaf as the main photosynthetic organ responds fast to environmental changes. The leaf as a place for food production and tree growth is the main food resources for livestock. The trees and forest structures are remarkably affected by livestock feeding [2].

The Zagros forests have been damaged by humans for decades, which has leading to its destruction in various forms. Even now, the destruction process continues and it is increasing. On the other hand, the growth of the population in recent years as well as the need of forest dwellers for firewood, food source for livestock and agricultural land has caused excessive exploitation of these forests, which has changed the face of these forests [3]. The factors of destruction in Zagros forests include heavy livestock grazing, understory farming, wood fuel for rural uses, outbreak of pests and diseases, and forest fire [4].

Trees in Zagros forests are grazed by nomadic livestock throughout the year, only unfavorable weather conditions (snow) prevent the presence of livestock in the forest. Nomadic livestock enter the forest area earlier than the legal deadline set for exploitation and leave the forest area later than the stipulated time [5].

The aim of this research was to investigate the leaf morphological characteristics of Zagros forest species under the livestock grazing.

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2. Methods

To carry out this research, after preliminary surveys and field visits, as well as consultation with experts, five forest areas were selected from the forests of Ilam province (Figure 1). The location of the masses was recorded using a GPS device (Table 1). A plot of about 10,000 square meters (one hectare) was selected from each forest stand, considering the distribution of trees and with the aim of sampling most of the tree species.

The selected forest areas are permanently grazed by the goats and sheep of the livestock farmers in the growing season from May to November. The number of livestock in the region is uncertain and varies according to the weather conditions of the current year and the breeding rate of livestock. Cattle are usually portable and transportable in the area and graze large areas of forests. Due to the large number of livestock and the long staying in the forest, no sign of regeneration and seed growth were observed in the forest floor.

Figure 1. The position of Ilam province and sampling stands.

Table 1. Fundamental characteristics of sampling sites.

Sampling site	Y UTM	X UTM	Elevation a.s.l (m)	M.A.T °C	Precipitation mm	R.H (%)
Arghavan	3721095	639495	1993	16.9	571	56
Karezan	3739210	634912	1510	18.5	546	45
Daalab	3729153	631053	1471	16.9	403.8	56
Pakal Gorab	3703981	659497	1247	16.9	729.5	56
Shena cheer	3711605	623473	1559	16.9	389.3	56

M.A.T.: Mean Annual Temperature. R.H.: Relative humidity.

In June, after the development of the leaves, five stands with signs of grazing were selected. About 50 pieces of leaf samples were randomly collected from the upper part of the tree that was not exposed to animal grazing and from the lower part that was easily used by the animal. The leaves were numbered based on the sampling area, the type of tree, and the induced stress and were placed in closed plastic and kept into refrigerator at a temperature of +4 ° C for further measurements.

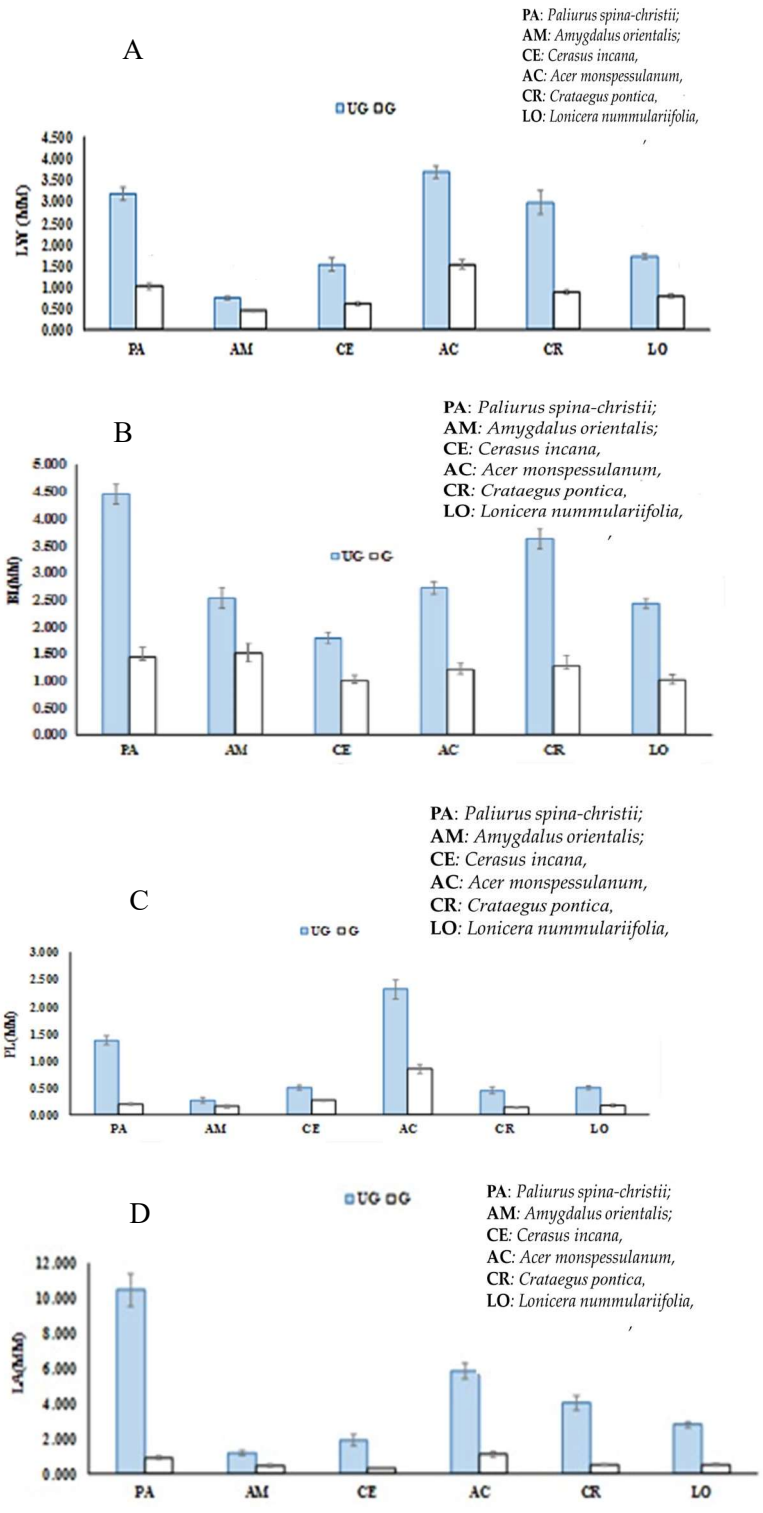
The woody tree species that were grazed by livestock were: *Crataegus pontica K.Koch, Acer monspessulanum L., Lonicera nummulariifolia* Jaub. and Spach, *Cerasus incana* Boiss., *Paliurus spina-christii* Mill., *and Amygdalus orientalis* Duh. Leaf width (mm), leaf length (mm), petiole length (mm), leaf area (mm^2), leaf dry weight (g) were the characteristics measured.

3.1. Statistical Analysis

At first, the homogeneity of the data was checked by the Schapro-Wilk test and the homogeneity of the variances was checked by the Lune test. Data analysis was done using paired t-test to compare the means at 95% confidence level. All data analysis was done using SPSS 20 software.

3. Results and Discussion

The results of the analysis of the morphological traits of the studied species showed that the effects of livestock grazing on the traits of leaf width and length, petiole length, leaf area, leaf dry weight were significant (Figure 2 A-E).



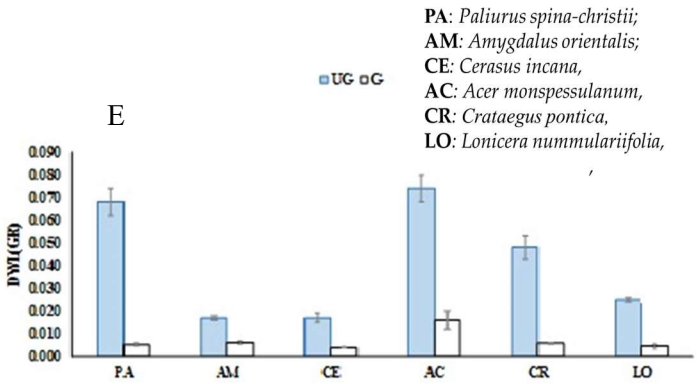


Figure 2. Mean comparison between the leaf traits under two different grazed (G) and ungrazed (UG) stresses. (A) Leaf width (mm); (B) leaf length (mm); (C) petiole length (mm); (D) leaf area (mm^2), and (E) leaf dry weight (g).

The livestock over-grazing on trees in the Zagros forests causes a change in the ecological diversities woody species and along with other destructive issues that harm the forests, impact on the forest diversity, structure, and finally their survival [6].

The leaves of trees as a place for food production and growth of trees are the main food used by livestock, that the life of trees is endangered by feeding on them [2]. Intensifying the use of leaves seriously damages the survival of trees and results into the forest decline. In such a situation, changes are evident in the form and shape of leaves and branches of trees, so that the plant can resist the grazing stress and being eaten by livestock. The growth rate of leaves, branches, as well as the production of flowers and fruits of trees is reduced, and in the long term, it reduces the potential production of the forest [6].

The main role of the petioles is to conduct the nutrients towards and out of the leaves. The longer the petiole is, the more water and nutrients are transferred to the leaves. The long length of the petioles causes more food and water to be transferred to the leaves and increases the photosynthetic rate and production in the plant at the beginning of the growing season [7]. The results of the present study showed that the petiole length in different studied species in grazed leaves was smaller than healthy leaves (Figure 2-C). Therefore, it was found that this trait is shorter in all the tree species affected by livestock grazing, and as a result, it reduces the exchange of water and nutrients in the leaves of the trees. The veins are the continuation of the petioles, so any change in the quantity and quality of the petioles will affect the functioning of the veins.

Due to the decreasing trend of the length and width of the leaf blade under the influence of livestock grazing, the leaf area also had the same decreasing trend, which was a logical and predictable result of the effect of grazing on the change in the morphological characteristics of the leaves (Figure 2-A, B, D). Environmental stresses cause a decrease in the surface of plant leaves [8]. Decreasing the leaf area of plants due to animal grazing causes a decrease in photosynthesis and defects in plant growth, as a result, it will reduce the amount of plant production and yield [9]. Grazing in each severity causes a decrease in the vegetative organs of the plant and makes a decrease in food production [10], which was completely consistent with the results of the present study.

The effect of livestock grazing was significant on the dry weight of leaves and caused a decrease in dry weight, which is in line with the findings of Mofidi [11]. It can be concluded that grazing avoidance traits are usually associated with low palatability, such as small leaf size and high leaf dry matter [12]. In contrast, grazing-tolerant plants should

have a high specific leaf area and low leaf roughness, which increases the stem regrowth ability and selectivity of herbivores [13].

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