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The effect of overgrazing on the physiological and morphological leaf traits of *Argania spinosa* L. Skeels under arid climate.

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INTRODUCTION

Knowledge of the complex interactions between aridity and overgrazing is very limited, which makes it difficult to estimate the consequences of global change on agro-silvo-pastoral ecosystems in general, and on the Arganeraie in particular. Studies conducted to date on the ecological impact of overgrazing in arid and semi-arid regions are not convincing and often contradictory. Indeed, the introduction of a new stress factor, climate change, makes the ecological implication of overgrazing in these ecosystems even more controversial (Jones, 2000). The combined and often synergistic effects of these pressures make ecosystems more vulnerable.

The objective of the present work is to study the impact of overgrazing on the morphology and physiology of the leaf of *Argania spinosa*. For this purpose, two plots were selected, one plot under protection and one plot under overgrazing. Several parameters were measured during three seasons (Spring, Summer and Autumn) in both plots: stomatal density, leaf area, dry weight of leaves, leaf mass area, pigment content, relative water content, Net photosynthesis, stomatal conductance, transpiration rate, water use efficiency, maximum photochemical efficiency of PSII and Effective quantum yield.

METHODOLOGY

1- Study site

2- Plant materiel

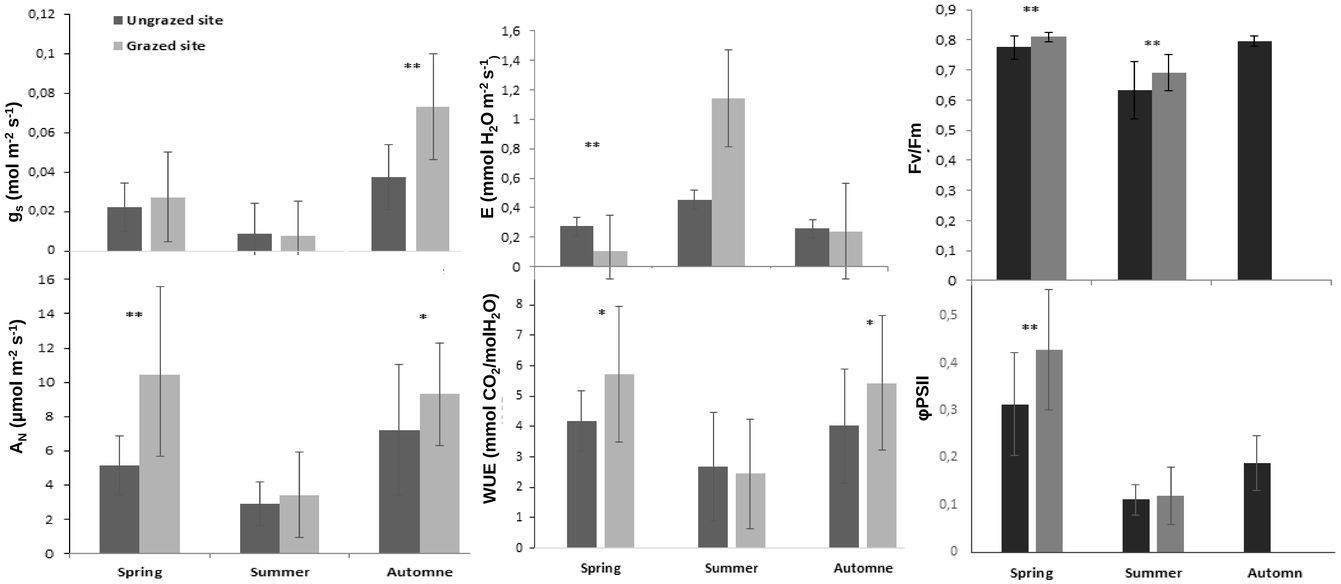
Argania spinosa leaves were collected from two parcels. An ungrazed parcel (red star) the other parcel was exposed to overgrazing (yellow star**).**

3- Methods

- Relative water content (RWC) declared by Barrs and Weatherley (1962).
- Leaf mass area (LMA), and leaf thickness (LT) according to Gratani *et al.*, 2006
- Stomatal density (SD) was calculated according to Galmes *et al.*, 2007
- Leaf dry weight (DM) Puglielli *et al.*, 2015.
- Gas exchange (A_{Net}, g_s, E and WUE) were carried out by an Infrared gas analyser (LCi-portable, ADC, UK)
- Chlorophyll fluorescence (Fv/Fm, ϕPSII) using a portable fluorimeter (OSp5+, ADC, UK). Schreiber *et al.*, 1986
- Pigment content by Lichtenthaler (1987)

RESULTS

Physiological traits:



Asterisks indicate significance levels for the comparison between the two sites within each season by student's t-tests (**P < 0.001; *P < 0.05).

- Net photosynthesis (A_N) was significantly high for grazed plants of *Argania Spinosa* in Spring (p<0,001) and autumn (p<0,05). In Summer, both sites showed the lowest values of the year.
- In Autumn, the grazed population showed the highest value of stomatal conductance (gs), with significant difference between the two sites (p<0.001).
- In grazed trees, maximum transpiration rate (E) occurred in Summer, and minimum values during Spring and Autumn. Moreover, significant differences were detected between the two sites in Spring (p<0.001).
- The lowest values of water use efficiency (WUE) were recorded in Summer in both sites, The grazed trees showed the minimum values. The highest values were recorded in grazed trees during Spring and Autumn, with significant difference between the two sites (p<0.05).
- In both sites, maximum photochemical efficiency of PSII (Fv/Fm) exhibited high values during Spring and Autumn, and minimum values in Summer. Significant differences were recorded between the two sampling sites during Spring and Summer (p<0.001).
- In both sites, effective quantum yield (ΦPSII) showed a seasonal pattern, with a pronounced decrease during Summer, and maximum values during Spring. Significant difference (p<0.001) was recorded between the two site in Spring.

Morphological traits:

	Ungrazed site			Grazed site		
	Spring	Summer	Automne	Spring	Summer	Automne
Relative water content	71,29±5,8	74,07±7,5	80,32±4,3	74,44±5,1	71,81±7,9	78,80±2,6
chlorophyll total	4,36±1,26	2,79±0,87	10,16±3,19	7,25±0,88	4,10±1,43	8,76±1,47
Chlorophyll a/b ratio	1,45±0,04	1,33±0,09	1,55±0,51	1,4±0,09	1,38±0,06	1,46±0,05
Leaf surface area (SA)	0,74±0,11	0,88±0,18	0,96±0,28	0,75±0,15	0,68±0,13	0,90±0,31
Leaf mass area (LMA)	91,97± 13,72	98,78± 15,68	82,52± 12,17	92,26± 11,78	103,84± 17,99	75,19± 15,78
Stomatal density	179,20±37	149,10±25	154,52±30	139,06±15	140,67±21	148,70±20

- **Leaf surface area** was affected by grazing, significant differences were recorded between both sites. Ungrazed trees exhibited the highest areas during Summer and Autumn.
- **Relative water content** (RWC) exhibited a seasonal pattern. **Leaf mass area** showed a similar pattern to that of RWC, except in Summer, where LMA exhibited higher value in grazed plants.
- **Total chlorophyll** content clearly showed a seasonal pattern, with the highest values measured in ungrazed trees in Autumn, and the lowest in Summer.

CONCLUSIONS

- This study found significant difference in physiological and morphological plant response among two sites with different management: grazed versus ungrazed.
- Our results revealed that the leaves of *A. Spinosa* were significantly influenced by herbivory. Trees from grazed conditions had higher photosynthetic performance than in ungrazed conditions during the favorable periods of Spring and Autumn. This enhancement of photosynthesis occurs after defoliation, this indicated that leaves were operating below their maximum photosynthetic potential before defoliation.
- Increased leaf-level photosynthetic activity following herbivore damage has been described as a mechanism of tolerance, and it may compensate for the lost leaf area and support the synthesis of induced chemical defenses (*Redondo-Gomez* et *al*, 2010).
- Although the Argan tree present a capacity to adapt to the arid climate. However, it requires a protection against the overgrazing. Our results suggest that an adequate grazing management may be a key control to increase the plant productivity.

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