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Enhancing the resilience of Saharan rangelands by reseeding drought tolerant native shrubs: the case of *Lygos raetam* in southern Tunisia

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Abstract

Lygos raetam is a desert and drought-tolerant shrub native to North Africa and West Asia. Goats and camels readily graze its fruits and flowers, and it is well known for its capacity to stabilise mobile sands.

This study was carried out in the communal rangelands of Dhahar, Saharan area of Southern Tunisia, to assess the impact of reseeding *L. raetam* on natural vegetation cover and sand mobility. A sandy rangeland site located at the border of the African Eastern Sand Sea was subjected to three management treatments: two years of rest, reseeding *L. raetam*, and free grazing (control). In all plots, total plant and perennial species percentage covers were determined and monitored for 5 years. Results showed that despite the improvement in the percentage of total vegetation cover recorded, the rest technique seems insufficient and inefficient in cases where vegetation degradation has reached an advanced stage. On the other hand, despite the negative effect of drought, there were considerable positive impacts of reseeding *L. raetam* on vegetation cover and active dune stabilization. The good establishment and survival of *L. raetam* seedlings may encourage rangeland managers and pastoral communities to undertake rehabilitation by reintroducing promising native Saharan species when ecosystems lose their natural resilience.

Introduction

In arid and Saharan areas of North Africa and more specifically in Southern Tunisia, several studies showed that they are subject to human and climate drivers that can result in reduced production and ecosystem functions and services (Jama and Zeila 2005; Ouled Belgacem and Louhaichi 2013). Overgrazing remains the primary anthropogenic factor impacting arid and semi-arid vegetation (Smet and Ward, 2005). Overgrazing is associated with overstocking and drought, further contributing to degradation, and reducing biodiversity and rangeland productivity (Ouled Belgacem et al. 2019).

Several attempts have been made to restore degraded rangelands in dry areas with exotic herbaceous species and shrubs (Zaafouri et al. 1994). Most of these attempts have largely failed due to the inability of the introduced species to adapt to the ecological constraints of the region. As a result, reseeding with native species has become a more attractive option (Aronson et al. 1993).

The irregular annual precipitation and frequent droughts that characterize desert zones affect native plant regeneration and growth, causing land degradation and amplifying desertification. Zaafouri et al. (1994) showed that the success of rangeland restoration depends on the choice of plant species adapted to soil and climatic conditions, adequate sowing techniques, and plant development control. For these reasons, restoration activities in arid zones require the investigation of local germplasms that present good flexibility and adaptation to unfavourable climatic conditions. However, restoration and rehabilitation with endemic germplasm require research into culture conditions and water deficit responses (Zaafouri 1993).

Lygos raetam (Forssk) Heywood is a xerophilic and psammophilic species in the Fabaceae family, common in arid desert ecosystems and widely distributed in North Africa and West Asia where it grows under unfavourable dry conditions. This shrub is well known for its significant role in combating wind erosion and stabilizing dunes and provides an important dietary source for camels. Flowers are well appreciated by small ruminants mainly goats. Additionally, this species represents a viable fuel source for humans (Cheriti et al. 2009) and different therapeutic virtues (Said et al. 2002).

This study is carried out in the El Mahmouda area, in the collective rangelands of Dhahar of Douz in Southern Tunisia, aiming at assessing the impact of rangeland rest and reseeding of *L. raetam*, on plant cover dynamics.

Methods

The experiment was conducted in the El Mahmouda zone, communal rangelands of Dhahar, desert area of southern Tunisia (mean annual rainfall is <80 mm). The zone covers 40000 ha with many micro-reliefs (small depressions, large dunes, etc.). The natural vegetation cover is very sparse and mainly dominated by perennial species such as *Rhanterium suaveolens*, *Haloxylon schmittianum, Stipagrostis pungens*, and *Anthyllis henoniana*. Annual species like *Savigna parviflora*, *Asphodelus tenuifolius*, *Schismus barbatus* and *Matthiola longipetala* are observed during wet seasons.

The study was carried out during the spring (March-April) of five years between 2008 and 2012. The experiment is established as a Completely Randomized Design (CRD) with three management treatments tested: i) strict protection, ii) reseeding *Lygos raetam,* and iii) free grazing (control). Each treatment was replicated three times (3 plots of 2500 m^2 area each).

For each management treatment and within each plot, five transects, 50 m long each, were installed. A fine pin was dropped straight down into the ground every 50 cm along the line. Each of the 100 hits per line was recorded according to the plant species. The results are expressed in terms of percentage vegetation cover (R, %) as:

$$R = (n / N) * 100$$

where n is the number of hits of all plant species and N is the total number of hits.

The data were analysed using analysis of variance (ANOVA) based on the CRD statistical model using SPSS (20.0).

Results

Analysis of variance of total plant cover showed highly significant differences ($P = 0.0001$) between applied management treatments (Table 1). The plots reseeded with *L. raetam* recorded significantly higher total plant cover compared to the protected ones. The lowest values were registered at the freely grazed plots. In these plots most of the plant species were annuals. However, there was also a relatively higher percentage

cover of other perennial species in the reseeded plots. Additionally, both total plant cover and *L. raetam* species cover showed a slight decrease with decreasing mean annual rainfall. Given the important contribution of the *L. raetam* seedlings to the total vegetation cover in the reseeded plots, its slight decrease confirms the high adaptation of this species to the harsh environment (Table 1).

Discussion

Lygos raetam species is a dominant perennial shrub in active sand dunes and stabilized sand fields in the Saharan zone of Tunisia. The results of the study confirm the reputation of the species for high tolerance of frequent droughts and water deficits. The establishment and survival of the seedlings seem to be attributed to their excellent root growth (Dhief et al., 2011), which enables plants to exploit a larger volume of soil, which may ensure recruitment success and testify thus an adaptive strategy to deal with drying soils and decreasing soil moisture.

Table 1. Total vegetation and *Lygos raetam* covers (%) with management modes according to mean annual rainfall. Values are means ± SD.

Year	Rainfall (mm)	Control		Rest		Reseed	
		Total	*L. raetam*	Total	*L. raetam*	Total	*L. raetam*
1	163.5	15±1.26	1..90±0.86	13..05±1.45	4.20±1.22	15.80±1.37	8.60±2.26
2	63	13.10±0.92	1.80±0.68	12.79±1.26	4.60±1.38	13.90±1.13	7.60±1.88
3	60.2	9.80±.09	1.20±0.28	10.60±1.50	3.60±1.48	11.52±1.99	6.50±1.78
4	62.8	8.40±0.82	1.50±0.38	10.40±0.47	3.40±0.82	11.02±0.69	6.10±1.69
5	130	8.40±0.35	1.50±0.42	11.70±1.32	3.50±1.66	13.80±1.29	6.18±1.44

On the other hand, the significantly higher total vegetation cover recorded in the plots reseeded by *L. raetam* may be attributed to the improvement of the availability of water and nutrients or the protection against direct irradiance and overheating (Moro et al., 1997) resulting from the small "islands of fertility" created around the plants of this Fabaceae species (Barakat et al., 2013).

L. raetam can grow and stabilize mobile sand dunes in conditions of extreme water deficit, and it appears to be suitable for revegetating and restoring degraded Saharan ecosystems. Thus, *L. raetam* can be suggested as one of the best species for the early stabilization of dunes and biomass production for livestock, mainly camels.

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