

The suitability for rehabilitation and the resistance to grazing of 11 plant-species in bentonite deposits in Milos Island

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The scope of work

- to establish species of phrygana and shrubs of various palatability to animals on fenced and non fenced slopes of mining deposits

In order to investigate:

- i) their adaptability in the existing climatic and soil conditions and
- ii) their resistance to grazing

Site description

- Location: at Zoulia site of Milos island
- Altitude: 110m
- On bentonite mining deposits
- Bio-climate is the intense thermo-mediterranean, with biologically dry days $> 125 < 150$
- Annual rainfall 404.5 mm
- 63 % steep inclination of the slope of the spoils' heap

Material and Methods

- The spoils derived from the waste soil material contain coarse fragments of varying size but mixed with a high percent of fine earth (>60%).
- As the fine material (<2 mm) of the spoils is poor in nutrient elements, the surface of the experiment was covered with a layer of natural soil (fine earth) 30 cm deep.

Material and Methods

11 species tested on the Zoulia site:

Pistacia lentiscus

Rhamnus alaternus

Medicago arborea

Limoniastrum monopetalum

Euphorbia dendroides

Anagyris foetida

Anthyllis hermanniae

Atriplex halimus

Calycotome villosa

Sarcopoterium spinosum

Phlomis fruticosa



Pistacia lentiscus



Rhamnus alaternus



Medicago arborea



Limoniastrum monopetalum



Euphorbia dendroides



Anagyris foetida



Anthyllis hermanniae



Atriplex halimus



Sarcopoterium spinosum



Calycotome villosa



Phlomis fruticosa

Experimental Design

The trial was

completely randomized blocks design,

2 treatments (in fenced and open area)

3 replications &

11 plots (species) / replication.

Plot of 12 plants, Spacing 1.0 m x 0.5 m

Planting on 29-30 November 2006

not watered, fertilized or hoed

Experimental plots in Zoulia site of Milos island



Experimental plots in Zoulia site of Milos island





Experimental plots in Zoulia site of Milos island



Experimental Design

A statistical **ANOVA**

the method of least significant difference (**LSD**) was used for the comparison of the means.

% of survival were transformed with the angular (arcsin) transformation

Measurements of

i) Survival

ii) Shrubs height

1st year and at the end of the 4th year

Comparison of survival (%) between fenced and non fenced plots at the end of 2010.

| Plant species | fenced | non fenced |
|---------------|--------|------------|
|---------------|--------|------------|

- | | | |
|------------------------------------|------|------|
| • <i>Medicago arborea</i> | 96a | 30b |
| • <i>Pistacia lentiscus</i> | 86a | 19b |
| • <i>Rhamnus alaternus</i> | 85a | 11b |
| • <i>Euphorbia dendroides</i> | 96a | 16b |
| • <i>Atriplex halimus</i> | 93a | 90a |
| • <i>Anagyris foetida</i> | 71a | 45b |
| • <i>Phlomis fruticosa</i> | 94a | 100a |
| • <i>Sarcopoterium spinosum</i> | 86a | 100a |
| • <i>Limoniasstrum monopetalum</i> | 99a | 98a |
| • <i>Anthyllis hermaniae</i> | 100a | 100a |
| • <i>Calycotome villosa</i> | 84a | 94a |

• *Means per row annotated with the same letter do not differ at the $p < 0.05$

Results

- The results of the fourth year (2010) **show significant losses in survival** between fenced and non fenced plots
- *Medicago arborea*
- *Pistacia lentiscus*
- *Euphorbia dendroides* &
- *Rhamnus alaternus*

Comparison of height (cm) between fenced and non fenced plots at the end of 2010.

| Plant species | 2010 | |
|----------------------------------|---------|------------|
| | fenced | Non fenced |
| • <i>Medicago arborea</i> | 46.15a | 12.07b |
| • <i>Pistacia lentiscus</i> | 18.92a | 9.89b |
| • <i>Rhamnus alaternus</i> | 13.49a | 5.83b |
| • <i>Euphorbia dendroides</i> | 50.52a | 7.56b |
| • <i>Atriplex halimus</i> | 100.64a | 56.48b |
| • <i>Anagyris foetida</i> | 35.09a | 26.66a |
| • <i>Phlomis fruticosa</i> | 38.55a | 35.28a |
| • <i>Sarcopoterium spinosum</i> | 27.10a | 27.47a |
| • <i>Limoniasrum monopetalum</i> | 39.27a | 36.75a |
| • <i>Anthyllis hermaniae</i> | 34.94a | 31.58a |
| • <i>Calycotome villosa</i> | 41.95a | 34.79a |

*Means per row annotated with the same letter do not differ at the $p < 0.05$

Results

- **The height at the end of 2010**
- *the mean height of all species being lower in the non fenced plots with the exception of *Sarcopoterium spinosum* retaining the same height in both treatments*
- ***the difference in height between fenced and non fenced becomes significantly lower only for *Medicago arborea*, *Atriplex halimus*, *Pistacia lentiscus*, *Euphorbia dendroides* & *Rhamnus alaternus*.***

Results

No of plants from natural regeneration/species on fenced and non fenced plots at the end of 2010.

| <u>Plant species</u> | <u>Fenced</u> | <u>Non Fenced</u> |
|-------------------------------------|---------------|-------------------|
| <i>Pistachia lentiscus</i> | - | - |
| <i>Anthylis hermaniae</i> | 7 | 8 |
| <i>Atriplex halimus</i> | 2 | - |
| <i>Calycotome villosa</i> | 14 | 4 |
| <i>Limoniastrum monopetalum</i> | - | - |
| <i>Sarcopoterium spinosum</i> | 15 | 100 |
| <i>Medicago arborea</i> | 31 | - |
| <i>Euphorbia dendroides</i> | 28 | - |
| <i>Rhamnus alaternus</i> | - | - |
| <i>Phlomis fruticosa</i> | 4 | 16 |
| <i>Anagyris foetida</i> | 2 | - |
| TOTAL | 103 | 128 |

Results

- **Natural regeneration**
- **in the fenced plots** for *Medicago arborea*, *Euphorbia dendroides*, *Anthyllis hermanniae*, *Atriplex halimus*, *Calycotome villosa*, *Sarcopoterium spinosum*, *Phlomis fruticosa*, *Anagyris foetida*,
- **in non fenced plots** only for
- *Anthyllis hermanniae*, *Calycotome villosa*, *Sarcopoterium spinosum*, *Phlomis fruticosa*, with *Sarcopoterium spinosum* as the dominant species

Results

- *Pistacia lentiscus* & *Rhamnus alaternus* did not produce any seeds and consequently no regeneration was observed,
- while *Limoniasstrum monopetalum* although it did produce seeds no new plants were found.

Conclusions

- *Phlomis fruticosa*, *Calycotome villosa*,
- *Sarcopoterium spinosum* and
- *Anthyllis hermaniae*,
- showing **satisfactory growth**,
- **high level of survival** and
- signs of **natural regeneration**, regardless of the grazing pressure,
- are the most suitable for the revegetation and the protection of sensitive slopes on the deposits of bentonite spoil materials in Milos island

Conclusions

- *Limoniastrum monopetalum* did not exhibit natural regeneration,
- *Anagyris foetida* and *Atriplex halimus* showed limited evidence and only in the fenced areas.
- Nevertheless, taking into the account **their resistance to grazing**, these species **can be also used for the revegetation** of these surfaces.

Conclusions

Pistacia lentiscus

- *it might perform better and*
- *the poor results in this particular case may be attributed to the small size of the plants or to other circumstantial factors.*
- ***The performance of all the other species tested show that they are not suitable, in the prevailing conditions and under grazing pressure, for rehabilitation of such sites.***

Thank you
for your attention