# Response of Mediterranean rangeland species (plant weight and mineral composition) to water conditions.

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## Abstract

An analysis of plant composition and plant weight of different rangeland species from Spain revealed that these species are largely dependent on the humidity of the habitats where they thrive. Rainfall increases plant weight and affects K and Na content in *Trifolium subterraneum*. Precipitation was found to be significant for P, Ca, Mg and Na uptake. Soil moisture affects Mg and Na uptake by plants.

Key words: plant composition, plant weight, rangeland plants, site humidity.

## Introduction

The ecological significance of drought as related to productivity depends upon the scale and ecosystem under consideration. Natural ecosystems can be viewed as nutrient-element conserving systems, controlled both by nutrient availability and climatic constraints. Ecosystem productivity largely depends upon the recycling of nutrient elements. The main environmental constraints of primary productivity are rainfall and temperature (Whittaker and Likens, 1973). Some groups of constraints are distinguished on a smaller scale basis, e.g. nutrient and water availability.

Soil environmental factors, such as pH and fertility, are important in determining the distribution of native plants. Plants rarely absorb various elements in the proportion in which these elements are present in their habitat. Striking differences have been found among plant species in their capacity to absorb specific elements from a given habitat. Nutrient status is also influenced by plant maturity, temperature, rooting depth and, specially, soil moisture. The analysis of plant material provides an indication of available nutrients in soil, and also defines its nutrient load, what is important when plant is ingested as food (Tiller, 1989). At the end of the food chain, animals and man are the ultimate recipients of nutrients formerly added to pastures and arable crops. It is becoming more readily acknowledged that the

maintenance of good animal and consequently human health should start with correct nutrition of crops and pastures.

There is relatively little background information about the concentration, distribution, or fluxes of nutrients in the grassland Mediterranean ecosystems of Spain. This contribution studies two environmental factors related to moisture status and the response of some forage herbaceous plants in Spanish rangelands. We present the results of wild subterranean clover populations from Western Spain and other rangeland species from the 'Dehesas' located South of the Central Mountain Range.

**Material and Methods**

Our experimental studies are based on plant samples from 179 natural populations, picked out from more than 500 *Trifolium subterraneum* L. (Ts) samples. The samples were collected from soils where they thrive, for the entire range of values of their distribution area in Western Spain. Fresh plant material was classified according to Katznelson (1974). Sampling stations and sampling plots were randomly selected.

Besides, some other pasture species from sixteen communities selected from fresh and moist environments were studied: *Trifolium cernuum* (Tc), *Ornithopus compressus* (Oc), *Bromus hordaceus* (Bh) and *Agrostis castellana* (Ac).

Plant tops (leaves, shoots, flowers and fruits) were collected mainly at the phenological stages corresponding to the end of the flowering and fructification seasons, in order to establish comparisons among materials from different localities with respect to their nutrient concentration.

Plant material was washed up with distilled water and then dried at 80°C to a constant weight. One gram of dried, ground plant was dry-ashed. The powder was slowly incinerated until fumes disappeared, then it was placed in a muffle furnace at 450°C for 10 hours. The ashes were digested by heating with a 1:1 HCl solution.

The rainfall data were found in published maps, and soil wetness data were obtained "in situ".

The differences in weights and nutrient contents of the subclover populations for the two environmental variables were tested by Analysis of Variance (F test).

## Results and Discussion

Rainfall effect was found to be significant for dry weight, ash weight and K and Na contents in *T. subterraneum* (Table 1). Rainfall increases plant weight. The highest plant weight takes place in areas that receive 800 to 1000 mm of rainfall.

The humidity type of the site was also significant for P, Ca, Mg and Na uptake by *T. subterraneum*. In spite of not having significant statistical results, the highest ash weight were obtained on humid and very humid sites. P, Ca, Mg and Na contents were lower on dry soils. *T. subterraneum* uptakes more Ca, Mg and Na in the weter sites.

Soil moisture is very highly significant for Mg and Na uptake by *T. subterraneum*, which readily absorbs these nutrients in moist sites, and hardly in dry sites. This species uptakes more K on very dry soils.

The ability to absorb Mg and Na by other rangeland species, collected in the same sites located at the 'Dehesas' south of the Central Mountain Range, is also related to soil moisture (Fig. 1). *Ornithopus compressus* and *T. cernuum* are the species that accumulate more Mg in moist soils, *O. compressus* also absorbs large amounts of Na in this type of sites. However, all species, mainly *T. subterraneum* and *Bromus hordaceus* accumulate less K. P is as well poorly absorbed in the case of *O. compressus* and *T. cernuum*.

*Agrostis castellana*, the most representative grass of these plant communities, takes up similar amounts of the different nutrients in both types of sites (more or less humid).

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**References**

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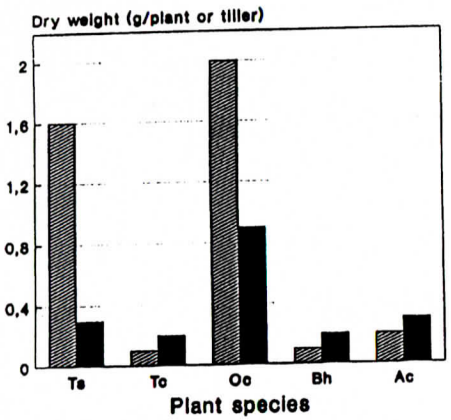
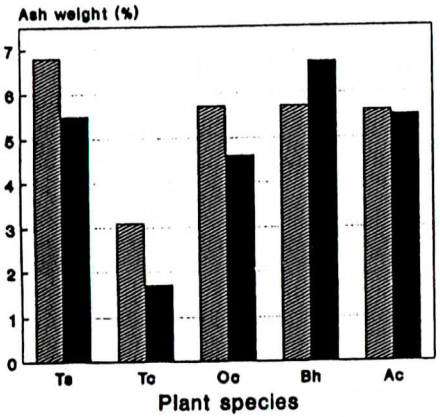
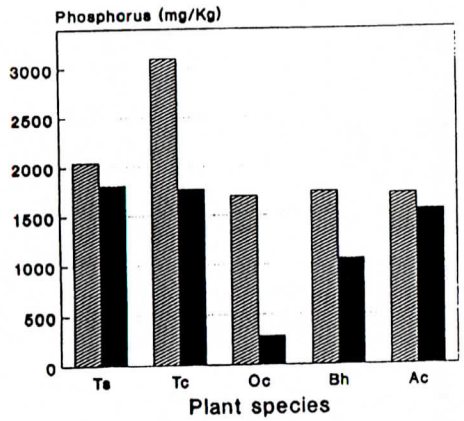
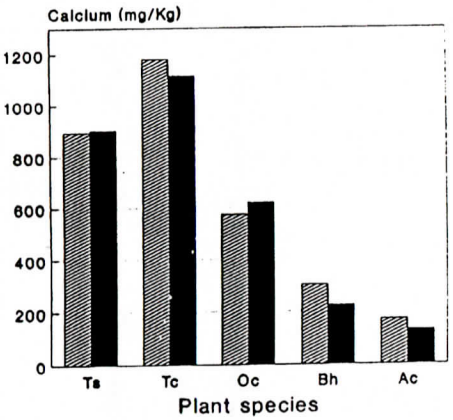
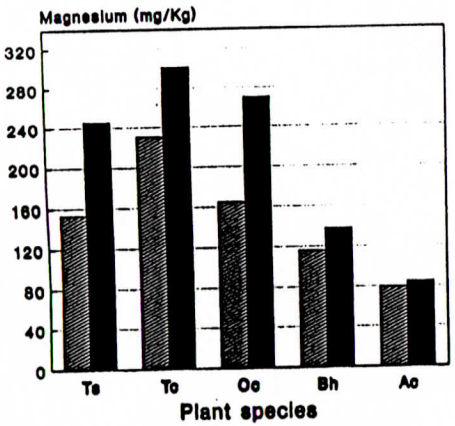
Whittaker, R.H. and Likens, G.E. (1973). Carbon in the biota. In: Carbon and the Biosphere, Woodwell, G.M. & Pecan, E.V.(eds), pp. 281-302. National Technical Information Service, Spingfield, Va (USA).

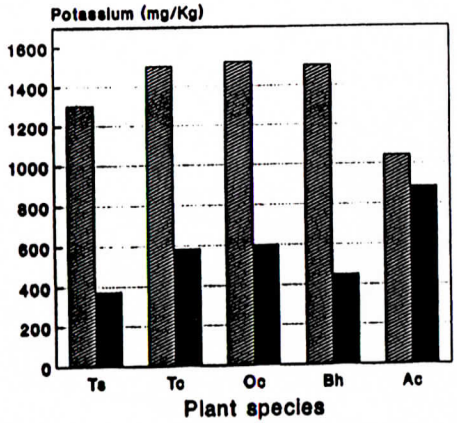

Dry weight (g/plant or tiller)
2
1,6
1,2
0,8
0,4
0
Ts
Tc
Oc
Bh
Ac
Plant species

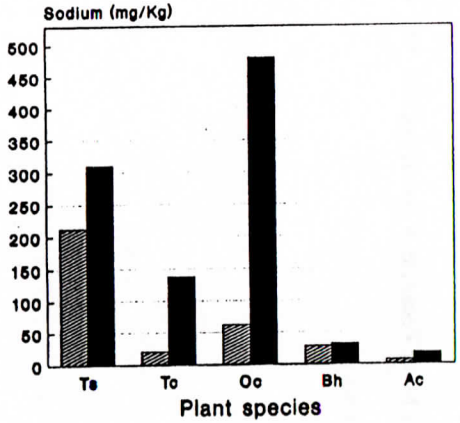

Ash weight (%)
7
6
5
4
3
2
1
0
Ts
Tc
Oc
Bh
Ac
Plant species


Phosphorus (mg/Kg)
3000
2500
2000
1500
1000
500
0
Ts
Tc
Oc
Bh
Ac
Plant species


Calcium (mg/Kg)
1200
1000
800
600
400
200
0
Ts
Tc
Oc
Bh
Ac
Plant species


Magnesium (mg/Kg)
320
280
240
200
160
120
80
40
0
Ts
Tc
Oc
Bh
Ac
Plant species


Potassium (mg/Kg)
1600
1400
1200
1000
800
600
400
200
0
Ts
Tc
Oc
Bh
Ac
Plant species


Sodium (mg/Kg)
500
450
400
350
300
250
200
150
100
50
0
Ts
Tc
Oc
Bh
Ac
Plant species


HUMIDITY
‹ Humidity
› Humidity

Figure 1

Table 1.- Environmental parameters (rainfall characteristics and humidity of the sites).

| ENVIRONMENTAL PARAMETERS | Dry weight (g/plant) | | | | Ash weight (%) | | | | Phosphorus (%) | | | | Calcium (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Samples | x | F | Probability level (%) | Number of Samples | x | F | Probability level (%) | Number of Samples | x | F | Probability level (%) | Number of Samples | x | F | Probability level (%) |
| **RAINFALL (mm)** | | | | | | | | | | | | | | | | |
| 400 - 600 | 51 | 597.5 | 2.79 | 95.8 | 51 | 8.65 | 3.53 | 98.4 | 51 | 0.21 | 1.38 | 75.0 | 51 | 1.27 | 1.57 | 80.1 |
| 600 - 800 | 59 | 543.5 | | | 59 | 8.41 | | | 59 | 0.23 | | | 59 | 1.26 | | |
| 800 - 1000 | 37 | 821.5 | | | 37 | 8.56 | | | 37 | 0.22 | | | 37 | 1.37 | | |
| > 1000 | 32 | 814.2 | | | 32 | 7.66 | | | 32 | 0.24 | | | 32 | 1.30 | | |
| **SITE HUMIDITY** | | | | | | | | | | | | | | | | |
| Very dry and dry | 17 | 494.5 | 1.30 | 72.7 | 17 | 7.71 | 1.86 | 88.0 | 17 | 0.18 | 2.70 | 96.8 | 17 | 1.16 | 2.59 | 96.1 |
| Quite dry | 29 | 506.4 | | | 29 | 8.24 | | | 29 | 0.23 | | | 29 | 1.22 | | |
| Average (with reserve) | 25 | 725.4 | | | 25 | 8.24 | | | 25 | 0.23 | | | 25 | 1.30 | | |
| Quite humid | 61 | 743.5 | | | 61 | 8.43 | | | 61 | 0.24 | | | 61 | 1.31 | | |
| Humid and very humid | 48 | 687.7 | | | 48 | 8.76 | | | 48 | 0.21 | | | 48 | 1.35 | | |

| ENVIRONMENTAL PARAMETERS | Magnesium (%) | | | | Potassium (%) | | | | Sodium (%) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number of Samples | x | F | Probability level (%) | Number of Samples | x | F | Probability level (%) | Number of Samples | x | F | Probability level (%) |
| **RAINFALL (mm)** | | | | | | | | | | | | |
| 400 - 600 | 51 | 0.27 | 1.02 | 61.5 | 51 | 2.23 | 5.85 | 99.9 | 51 | 0.26 | 3.32 | 97.9 |
| 600 - 800 | 59 | 0.29 | | | 59 | 1.75 | | | 59 | 0.43 | | |
| 800 - 1000 | 37 | 0.28 | | | 37 | 2.01 | | | 37 | 0.33 | | |
| > 1000 | 32 | 0.27 | | | 32 | 1.67 | | | 32 | 0.32 | | |
| **SITE HUMIDITY** | | | | | | | | | | | | |
| Very dry and dry | 17 | 0.23 | 4.58 | 99.9 | 17 | 1.97 | 0.10 | 1.7 | 17 | 0.10 | 5.34 | 100.0 |
| Quite dry | 29 | 0.27 | | | 29 | 1.86 | | | 29 | 0.33 | | |
| Average (with reserve) | 25 | 0.26 | | | 25 | 1.90 | | | 25 | 0.28 | | |
| Quite humid | 61 | 0.28 | | | 61 | 1.95 | | | 61 | 0.35 | | |
| Humid and very humid | 48 | 0.30 | | | 48 | 1.93 | | | 48 | 0.47 | | |

# WORKSHOP PROCEEDINGS

**of the 15th General Meeting of the**
**European Grassland Federation**
**Wageningen, The Netherlands**
**6 - 9 June 1994**