

# [Intrinsic water use efficiency: carbon isotopic composition](https://assignbuster.com/intrinsic-water-use-efficiency-carbon-isotopic-composition/)

Determination of intrinsic water use efficiency of different Mediterranean forest species by carbon isotopic composition

### Abstract

An experiment will be conducted to study the C-13 composition in the tissues of Pinus halepensis , Quercus ilex and Arbutus unedo under different water availability conditions . C-13 composition will be determined using elemental analyser. An ANOVA will be conducted to analyze the composition of C-13 within the plant tissue of plants in different water availability conditions. We will compare the C-13 compositions in the plant tissues of the species within same year with relation to water availability. The relationship between the C-13 composition in the plant tissue and water use efficiency (WUE i ), different strategies to couple water stress will also be discussed.

## Introduction

The Mediterranean landscape has low precipitation and humidity, and high sun intensity with less productive soil (FAO, 2010). Previous studies show that changes are occurring in the amount, intensity, frequency and type of precipitation with climate change. Mediterranean Forests are generally composed of broadleaf and pine species. All the species have different water requirements. It is needed to determine the intrinsic water use efficiency of main species (Pinus halepensis, Arbutus unedoandQuercus ilex) of the landscape for better compositional management of the landscapes keeping in view the water demands of the species.

## Literature review

The Mediterranean region has limited and unevenly distributed water resources with only 1. 2% of total renewable water resources (FAO, 2010). The basin has high sun light and low humidity. The freshwater resources are expected to decrease upto 20-30% in 1950 due to global warming. The mediterranean region is most vulnerable to the climate change (Milano et al., 2012). The region is rich in biodiversity. Quercus (broad leaf) is well-represented genus, with a great range of species including Q. ilex (FAO, 2010). Oak is also a heritage plant in Portugal (Galmés et al., 2007). Pinus halepensis and Arbutus unedo are the two other prominent species of the Mediterranean region (Molina et al., 2012). P. halepensis has water saver behavior and Q. ilex behaves like water spender (Baquedano et al., 2006). Water stress affects the vegetation production by a reduction of the leaf area, the stomatal conductance and the CO 2 uptake and hence of the photosynthesis, and by a slowdown of root elevation and development (Verstraeten et al., 2006). Under water stress conditions, plants exhibit several short to long-term adaptive responses. Reduced stomatal conductance (gs) and transpiration (E) due to closing of stomata (gs) is the first functional adaptations to water shortage (Galmés et al., 2007). The adaptive responses are related with carbon splitting and create changes in vegetative and fruit growth (Chalmers and Ende, 1975: Hsiao, 1973). The intensity and duration of water stress, whether imposed via irrigation or resulting from natural drought, may affect leaf gas exchange and nutrient uptake (Boyer, 1996 and Flexas and Medrano, 2002). Oak tree minimizes water potential of the leave to extract water from a region of higher water potential that is soil (Guehl and Aussenac, 1987; Lo Gullo and Salleo, 1988).

Plant takes carbon (C-12 and C-13) during photosynthesis. In normal water conditions, Plants prefer carbon 12 during photosynthesis (Farquhar et al., 1989). This is called carbon-12 discrimination (Craig, 1957). The discrimination takes place in two levels. Firstly, it takes place during gas exchange through stomata. Secondly, the discrimination is by RuBisCO enzyme (Farquhar et al., 1989). In stressed conditions, plants tend to minimize water loss through closing stomata. This will also decrease the gaseous exchange through stomata. In this condition, there is not adequate carbon dioxide in the leave tissue for photosynthesis. So plants have no more preference for carbon-12. They take both carbon-12 and carbon-13 (Ferrio, 2003).

## Problem statement

Mediterranean ecosystems are strongly limited by a long and intense drought period that coincides with the hottest period. Moreover, in the next decades, the Mediterranean region of the Iberian Peninsula is predicted to face a 20% decrease in precipitation, and an increase of 2–3°C in temperature (MARM, 2009), all of which will lead to higher water stress. Plant growth in the region is strictly limited by drought in recent scenario (Rey and Alcántara, 2000, Quero etal., 2008andGonzález-Rodríguez etal., 2011). The field simulations suggest that in future, this will become even more problematic (Matías etal., 2012) due to climate change (Milano et al., 2012). The pressure on freshwater resources will also increase because of tourism, tanning, food and textile industry and agriculture sector. Possible future changes in water resources availability in this densely populated region may have dramatic societal and environmental effects (Gracia-Ruiz et al., 2011). With shortage of water, we have to face desertification, erosion and food security problem. Both broad and narrow leaf species are inhabited here (FAO, 2010). All species of the landscape vary in their water requirement. Some species consumes more water than the others. So we have to identify the species with lower water requirement and better strategies to cope the water scarcity problem. It is needed to determine the intrinsic water use efficiency of main species (Pinus halepensis, Arbutus unedoandQuercus ilex) of the landscape for better compositional management of the landscapes keeping in view the water demands of the species.

### Research Questions:

* Which one is the best suited species among P. halepensis, A. unedoandQ. ilex for the water scarced Mediterranean landscape?

Specific Objectives:

* To analyze the intrinsic water use efficiencies of P. halepensis, A. unedoandQ. ilex over space.
* To analyze the intrinsic water use efficiencies of P. halepensis, A. unedoandQ. ilex over time to determine the best species for the future landscape composition to minimize the water consumption.
* To determine variability in water requirements of the P. halepensis, A. unedoandQ. ilex

### Hypothesis:

Intrinsic water use efficiency of P. halepensis, A. unedoandQ. ilex is same and they consume same amount of water.

There is no variability in the water requirement of P. halepensis, A. unedoandQ. ilex over space.

### Limitation

The time to analyze the temporal and spatial changes is short.

### Materials and Methodology

Plant samples of three species will be collected from botanical garden, arboretum of University of Lleida, Spain. The water supply will be artificially varied. Carbon-13 composition of collected samples will be analyzed by Europa Scientific 20-20 IRMS coupled to a Europa Scientific elemental analyser. Plant C-13 analyses are currently used for a diverse range of applications including environmental (Ferrio, 2003) and ecophysiological studies (Arens et al., 2000; Kohn, 2010). The data will be analyzed by ANOVA.

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