# Root growth potential and seedling morphological attributes of four Mediterranean plant species

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## Introduction

In many Mediterranean ecosystems due to large and longstanding human impacts, degradation processes appear in extended heterogeneous areas which they need to be restored. The lack of a reliable nursery practice to assess quality of planting stocks led to the failure of many reforestation and restoration projects. The rapid development of underground and aboveground section of the plants, are factors that directly related to the success of plantings. Thus, it is important to develop a mechanism to evaluate nursery seedling quality and performance prior to field planting. Knowledge of the root growth potential and familiarity with the plant root system is a key to understand ecological fundamentals that influence seedling quality and subsequent growth.

## The aim

This study was conducted to evaluate two measures of Root Growth Potential (number and length of new roots of first and second order appeared in standard time), central root length and shoot morphological characteristics as seedling performance attributes of four Mediterranean plant species; *Cercis siliquastrum, Paliourus spina-christi, Quercus ilex, Pistacia lentiscus*, which could be used for reforestation and restoration projects.

## Materials and Methods

After the appropriate treatments for improving seed germination, seeds of the studied species were sown in pots. For the unrestricted growth of the taproot, the acorns of *Q. ilex* planted in cylindrical PVC pots with a diameter of 10 cm and 20 cm deep. The seeds of the other species were sown in plastic pots of twenty-four cells each. The cell capacity is 330 cubic cm and depth 16 cm. All pots were filled with peat-perlite (1:1). The seeds of all species were sown in mid-February. Three months after the sowing, twelve seedlings per species were randomly extracted for destructive sampling. After 20 days the same number of seedlings were also randomly extracted for the same measurements.

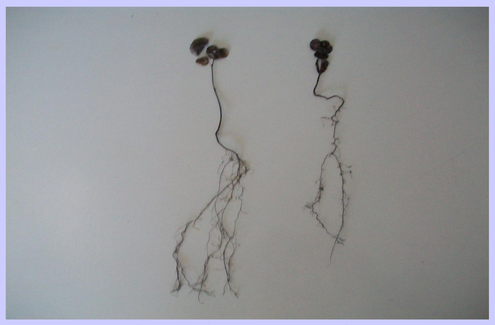
RGP (root growth potential) and the other morphological characteristics were determined in two extraction dates (after 3 months from the sowing and 20 days later). Also, the existence of any correlations was investigated to determine whether a relationship exists between belowground and aboveground plant growth.

After 20 days - before

*Paliourus spina-christi*

After 20 days - before

*Pistacia lentiscus*



After 20 days - before

*Cercis siliquastrum*

After 20 days - before

*Quercus ilex*

## Results

Table 1. Root and shoot morphological parameters

| | *Cercis siliquastrum* | *Paliourus sprina-christi* | *Quercus ilex* | *Pistacia lentiscus* |
|---|---|---|---|---|
| Height of shoot (cm) | 3,76 (0,34) * | 5,8 (0,30) | 9,46 (0,72) | 3,22 (0,16) |
| Height of shoot after 20 days (cm) | 7,0 (1,15) * | 6,34 (0,61) | 10,94 (0,62) | 3,47 (1,18) |
| Increase (%) | 86,7 | 9,3 | 16,4 | 15,5 |
| Diameter (mm) | 1,06 (0,07) | 1,58 (0,08) * | 2,99 (0,19) | 0,98 (0,04) * |
| Diameter after 20 days | 1,13 (0,06) | 1,93 (0,11) * | 3,32 (0,14) | 1,27 (0,06) * |
| Increase (%) | 6,6 | 22,2 | 11,0 | 27,6 |
| Length of central root (cm) | 16,07 (2,01) | 16,11 (1,06) | 31,56 (1,72) | 9,25 (0,98) * |
| Length of central root after 20 days (cm) | 19,21 (0,75) | 16,40 (0,78) | 32,85 (2,30) | 15,58 (0,84) * |
| Increase (%) | 19,5 | 1,8 | 4,1 | 65,4 |
| Number of first- order roots | 32,08 (4,22) * | 51,58 (4,2) | 97,3 (8,82) | 19,16 (1,98) * |
| Number of first- order roots after 20 days (cm) | 48,53 (3,16) * | 52,41 (3,1) | 119,8 (13,64) | 34,61 (3,70) * |
| Increase (%) | 51,3 | 1,6 | 23,1 | 80,6 |
| Length of the longest first- order root (cm) | 7,89 (1,20) | 7,17 (1,10) * | 12,9 (1,84) | 3,1 (0,76) * |
| Length of the longest first- order root after 20 days (cm) | 10,54 (0,66) | 11,33 (0,85) * | 17,23 (1,33) | 10,66 (1,17) * |
| Increase (%) | 33,6 | 57,6 | 33,6 | 226,5 |
| Number of second-order roots | 17,16 (3,26) * | 73,5 (9,33) * | 81,3 (24,99) * | 6,58 (2,61) * |
| Number of second-order roots after 20 days (cm) | 44,38 (7,81) * | 125,46 (20,56) * | 253,4 (46,72) * | 40,15 (6,65) * |
| Increase (%) | 158,6 | 70,7 | 211,7 | 473,7 |
| Number of Leaves | 4,5 (0,23) | 9,66 (0,43) | 6,1 (0,50) * | 6,9 (0,25) * |
| Number of Leaves after 20 days | 5,07 (0,24) | 10,15 (0,67) | 8,80 (0,88) * | 9,0 (0,54) * |
| Increase (%) | 12,7 | 5,1 | 44,3 | 30,2 |

*: significant differences (p<0.05, t-test).

Table 2. Correlations among the morphological attributes of seedlings of *Cercis siliquastrum*

| Cross-correlations characteristics | Length of central root | Number of first order roots | Length of longest first order root | Number of second order roots | Number of leaves |
|---|---|---|---|---|---|
| Height of shoot | | | | | 0,750** |
| Diameter | 0,562** | | 0,567** | | |
| Length of central root | | 0,721** | | | 0,718** |
| Number of first-order roots | | | 0,408* | 0,576** | 0,526** |
| Length of the longest first order root | | | | 0,673** | |

* : significance p<0.05

** : significance p<0.01

Table 3. Correlations among the morphological attributes of seedlings of *Paliourus spina-christi*

| Cross-correlations characteristics | Length of central root | Number of first order roots | Length of longest first order root | Number of second order roots | Number of leaves |
|---|---|---|---|---|---|
| Height of shoot | | | 0,396* | 0,765** | 0,832** |
| Diameter | 0.403* | | 0.577** | 0,715** | |
| Length of central root | | 0,809** | | 0,496* | 0,440* |
| Number of first order roots | | | | 0,465* | |
| Length of longest first order root | | | | 0,667** | 0.407* |
| Number of second order roots | | | | | 0,702** |

* : significance p<0.05

** : significance p<0.01

Table 4. Correlations among the morphological attributes of seedlings of *Quercus ilex*

| Cross-correlations characteristics | Diameter | Length of central root | Number of first order roots | Number of second order roots | Number of leaves |
|---|---|---|---|---|---|
| Height of shoot | 0,634** | 0,486* | 0,497* | 0,556* | 0,470* |
| Diameter | | | 0,453* | | 0,492* |
| Length of longest first order root | | | | 0,761** | |

* : significance p<0.05

** : significance p<0.01

Table 5. Correlations among the morphological attributes of seedlings of *Pistacia lentiscus*

| Cross-correlations characteristics | Length of central root | Number of first order roots | Length of the longest first order root | Number of second order roots | Number of leaves |
|---|---|---|---|---|---|
| Diameter | 0,579** | 0,648** | 0,562** | 0,621** | 0,696** |
| Length of central root | | 0,778** | 0,575** | 0,550** | 0,472* |
| Number of first order roots | | | 0,684** | 0,734** | 0,571** |
| Length of the longest first order root | | | | 0,892** | 0,595** |
| Number of second-order roots | | | | | 0,676** |

* : significance p<0.05

** : significance p<0.01

## Conclusions

✓ Three months after sowing, great morphological differences were observed among studied seedlings.

✓ *Cercis siliquasrtum* seedlings showed the greatest height growth while *Paliurus-spina cristi* and *Pistacia lentiscus* seedlings showed the greatest diameter growth, in the same period. The fast early growth of newly planted seedlings is the ideal because it decreases the risks from competing vegetation, mammals and frosts.

✓ Of the species studied, the highest root growth potential showed seedlings of *Pistacia lentiscus* , followed by seedlings of *Cercis siliquastrum* , *Paliurus spina cristi* and *Quercus ilex.*

✓ Also, *Pistacia lentiscus* seedlings presented the greatest central root growth.

✓ Finally, based on the results from root growth potential we can suggest that all species studied and especially *Pistacia lentiscus* can be used for restoration and reforestation projects, because an increased number of first-order and second order lateral roots and RGP have shown some correlation to improved field performance.

✓ However, the RGP results should be interpreted cautiously when using them as an indicator of seedling performance potential, because the validity of the RGP as a measurement of seedling vigour is largely a function of site conditions and its predictive ability increasing as the site becomes harsher.

✓ The correlations observed among the morphological seedling attributes lead us to conclude that, when they are strong, we can evaluate the root system, measuring aerial characteristics such as diameter and height of the shoot. More research is needed to determine whether these positive signs for the quality of plants, maintained over time, increasing the success of rehabilitation.