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Could the long term cover change of three Mediterranean shrubs be explained by their photosynthetic responses to drought in a rainfall exclusion experiment ?

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In the Mediterranean climates water stress is considered to be the main environmental factor limiting plant growth. In front of water limitations plants have developed a wide diversity of adaptation mechanism, and co-occurring species often display different physiological, functional, and life history strategies. In the contest of a rainfall exclusion experiment (project INCREASE), the present work is aimed to assess if the seasonal response of photosynthesis to the water stress (based on gas exchange data collected during 2010) can explain the long term change in the cover degree (assessed by seven pin point survey carried out from 2001 to 2012) of the three main species present in the Italian experimental site, Cistus monspeliensis L. (Cistaceae), Dorycnium pentaphyllum Scop. (Fabaceae) and Helichrysum italicum subsp. microphyllum (Willd.) Nyman (Asteraceae)
From 2001 to 2012, in the untreated plots, the cover degree increased in C. monspeliensis (+ 0.34% per year), did not show any significant trend in D. pentaphyllum and decreased in H. italicum (- 1.54% per year). In the same period the rainfall exclusion system has worked during Spring and Autumn, mainly reducing the soil water content of the drought plots in Autumn: this treatment did not affect the cover trend of D. pentaphyllum and H. italicum, whereas C. monspeliensis displayed in the drought plots an opposite dynamic (- 1.23% per year) compared to the natural conditions.
During 2010 all monitored species reached the maximum photosynthesis rates in spring, with a depression during summer drought and a recovery after the first Autumn rainfalls. The recovery of the spring rates was almost complete in C. monspeliensis and D. pentaphyllum, while in H. italicum did not exceed the 30% of the spring value. The rainfall exclusion reduced the photosynthesis rates in C. monspeliensis and H. italicum in Autumn.

In the control plots the opposite cover trend observed in C. monspeliensis and H.italicum could be connected to the different ability of the two species in keeping high photosynthesis rates during the Autumn period, that could imply a limitation in the growth and therefore in the competitive ability of H. italicum. The lower ability of D. pentaphyllum in gain cover with respect to C. monspeliensis, despite the similar photosynthetic seasonal trend, could be related to the different resource allocation pattern connected to the deep root system, that only characterize this species. The strong effect of the rainfall exclusion on the cover trend of C. monspeliensis , compared to no effect observed in H. italicum, could be explained by the timing of the drought treatment, affecting C. monspeliensis during one of the two annual photosynthetic peaks, H. italicum during a period of low photosynthetic activity.
It seems therefore possible to find some connection between the population dynamics of the studied species and their ability in recovering after the drought stress; furthermore, the lengthening of the dry season, as simulated by the rainfall exclusion system, in the long term seems to impact more on those species, like C. monspeliensis, relying on Autumn period to perform a significant part of their annual assimilation.