Analysis of phenological functional traits as a contribution for a network of Biodiversity - Ecosystem Functioning (BEF) experiments: the International Diversity Experiment Network with Trees (IDENT)

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Abstract
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Abstract

Forests play a significant role in climate change mitigation by acting as "sinks", absorbing carbon from the atmosphere and storing it in biomass and soils. Reforestation with multiple tree species is considered as an important strategy for improving forest resistance against natural threats. However, particularly in drylands, reforestation often fails because seedlings suffer from severe environmental conditions in degraded areas (Gómez-Aparicio, 2009).

The adoption of polyculture plantations, instead of conventional large-scale monocultures, provides long-term benefits for dealing with climatic uncertainties (van der Plas et al., 2016). The relationship between biodiversity and forest functioning is primarily explored in mature systems, but interactions mechanisms in the early forest stages are much less investigated.

As positive interactions between species could help to overcome environmental stress leading to improved survival of seedlings, there is a strong need to better understand how the different components of diversity, i.e., species richness and functional diversity, contribute to ecosystem functioning (Tobner et al., 2016).

The International Diversity Experiment Network with Trees (IDENT) (Tobner et al., 2014; Verheyen et al., 2016) investigates questions related to intraspecific trait variation, complementarity, and environmental stress conducting research at several hierarchical levels: within individuals, neighborhoods, and communities. The goal of IDENT is to identify some of the mechanisms through which individuals and species interact to promote coexistence and the complementary use of resources. Temporal complementarity, i.e. use of resources at different times of the year, is believed to be one of the mechanisms leading to positive BEF relationships. In this sense, it is fundamental to understanding how species differently regulate their phenological phases. This study was conducted in the experimental garden located at the nursery "St. Antonio - Sardinian Forest Authority" in Macomer, Italy (40°14' N; 8°42' E; 640 m above sea level). The experimental design properly replicated all monocultures and a selection of mixed communities with different levels of species richness (SR) and functional diversity (FD) considering a total of 12 species (Van de Peer et al., 2018).

In this work, results on the characterization of phenological functional traits for the studied species are reported. An analysis of digital images was performed by the use of chromatic coordinates indices: start and duration of the growing season were determined, and the physiological status in relation to environmental drought conditions was evaluated. Six digital cameras (CC5MPX, Campbell Scientific, Logan, UT, USA) were set-up and installed on a metal pole, at 2.5 m height above ground, pointing north and west to avoid direct sun light in the camera lens as much as possible, to obtain a view scene captured by each camera containing different species. The images were collected daily for a 2-year period (April 2017 - April 2019). The ground-based phenophases for each individual were determined visually. Moreover, a digital image processing was performed using the software application MATLAB (R2015b, The MathWorks, Natick, Mass.). Reflectance information were extracted as digital numbers (DNs) and several colour indices were derived.

Information from this study can provide a valid contribution to a more detailed understanding on how individuals regulate the way in which species temporally interact within a community, and how manipulating tree species composition can overcome barriers of plant settlement in dry habitats.

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