Environmental and Experimental Botany 141 (2017) 170–180

Contents lists available at ScienceDirect

Environmental and Experimental Botany

journal homepage: www.elsevier.com/locate/envexpbot

Does long-term warming affect C and N allocation in a Mediterranean shrubland ecosystem? Evidence from a ^{13}C and ^{15}N labeling field study

O. Gavrichkova[a,*], D. Liberati[b], A. Gunina[c,f], G. Guidolotti[b,d], G. de Dato[e], C. Calfapietra[a], P. De Angelis[b], E. Brugnoli[a], Y. Kuzyakov[c,g]

[a] Institute of Agro-Environmental and Forest Biology, National Research Council, 05010, Porano (TR), Cintetesino (TN), Italy
[b] Department for Innovation in Biological, Agro-food and Forest Systems, University of Tuscia, Viterbo, 01100, Italy
[c] Department of Soil Science of Temperate Ecosystems, Department of Agricultural Soil Science, University of Göttingen, Göttingen, 37077, Germany
[d] Institute of Agro-Environmental and Forest Biology, National Research Council, Via Salaria, 00015 Monterotondo Scalo, RM, Italy
[e] Council for Agricultural Research and Economics – Research Centre for Forestry and Wood (CREA-FL), V.le Santa Margherita, 80, 52100 Arezzo, Italy
[f] Department of Soil Biology and Biochemistry, Dokuchaev Soil Science Institute, Russia
[g] Institute of Environmental Sciences, Kazan Federal University, 420049 Kazan, Russia

ARTICLE INFO

Keywords:
Climate change
Temperature increase
Respiration
Photosynthesis
Cistus
C cycle
N cycle

ABSTRACT

In the Mediterranean basin the effects of climate warming on ecosystem functioning will strongly depend on the warming intensity directly but also on its effects on evapotranspiration and nutrient cycling. Climate manipulation experiments under field conditions are a source of unique empirical evidence regarding climate-related modifications of biotic processes.

A field night-time warming experiment, simulating the predicted near-future increase in ambient temperatures (+0.3 up to 1 °C), was established in a Mediterranean shrub community located in Porto Conte (Italy) in 2001. After 11 years of continuous treatment, we labeled the dominant shrub *Cistus monspeliensis* with $^{13}CO_2$ and studied the dynamics of the label allocation between aboveground and belowground pools and fluxes in warmed and ambient plots within 2 weeks of the chasing period. The interactions between C and N metabolism were assessed by parallel labeling of soil with $K^{15}NO_3$.

Most of the assimilated ^{13}C was respired by *Cistus* shoots (28–51%) within two weeks. *Cistus* under warming respired more ^{13}C label and tended to allocate less ^{13}C to leaves, branches and roots. The higher C and N content in microbial biomass in warming plots, combined with the higher N content in plant tissues and soil, evidenced a greater N mobilization in soil and a better nutrient status of the plants as compared to the ambient treatment. Acceleration of N cycling is probably responsible for higher respiratory C losses, but combined with the reduction in the number of frost days, should also positively affect plant photosynthetic performance.

We conclude that, although *Cistus* plants are already growing in conditions close to their thermal optimum, long-term warming will positively affect the performance of this species, mainly by reducing the nutrient constraints. This positive effect will highly depend on the frequency and amount of rain events and their interactions with soil N content.

1. Introduction

Greenhouse gas emissions continue unabated, and rapid changes in the global climate are predicted. During the 20th century the global temperatures have risen by 0.6 °C. A further increase of 0.3–0.7 °C is forecast for the period 2016–2035 (IPCC et al., 2014). Parallel to the temperature rise, an intensification of the hydrological cycle and increase in the frequency and severity of climate extremes are expected (Jentsch et al., 2011; Frank et al., 2015).

The Mediterranean basin is one of the most biologically rich and climatically complex regions on Earth due to its unique location (Blondel, 2010). Climate change here is expected to follow trends different from the global average: summer warming will be more intense in the Mediterranean area and it will be accompanied by a further decrease in summer precipitation, significantly intensifying summer droughts (Christensen et al., 2007; IPCC et al., 2014). Therefore, the success of biodiversity conservation, carbon (C) sequestration and related ecosystem functions will depend on the ability of Mediterranean

Abbreviations: A, ambient treatments; W, warming treatment; EC, extractable carbon; EN, extractable N; *Cistus*, *Cistus monspeliensis*

* Corresponding author.
E-mail address: olga.gavrichkova@ibaf.cnr.it (O. Gavrichkova).

http://dx.doi.org/10.1016/j.envexpbot.2017.07.013
Received 22 February 2017; Received in revised form 22 June 2017; Accepted 19 July 2017
Available online 23 July 2017
0098-8472/