Plant functioning in a changing global atmosphere

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EDITORIAL

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The combustion of fossil fuels and land-use changes, associated with transport, industrial and agricultural practices have caused and will further result in striking increases in long-lived greenhouse gases in the atmosphere, including carbon dioxide (CO_2), methane (CH_4) and oxides of nitrogen (NO_x). For example, the average atmospheric CO_2 concentration has risen by about 120 ppm over the past 250 years to a current global average concentration of approximately 409 ppm, and future rapid increases are expected, with values likely to reach 550 ppm by mid-century and 1000 ppm by the end of this century (IPCC 2014). Similarly, tropospheric ozone (O_3), a secondary pollutant formed as a by-product of the photochemical oxidation of NO_x in the presence of carbon monoxides (CO), methane (CH_4) and non-methane hydrocarbons has increased significantly over the same time period, making O_3 the third most potent anthropogenic greenhouse gas after CO_2 and CH_4 (Danielewska *et al.* 2013).

Greenhouse gases contribute significantly to radiative forcing and are the main drivers of global warming. Under a range of greenhouse gas emission scenarios, the global temperature is predicted to increase by 1.8 to 4.0 °C by the end of this century (IPCC 2014). In addition, extreme weather events such as heat- and cold-waves become more frequent and precipitation patterns change, with some regions experiencing increased precipitation while others are expected to experience substantial droughts. Climate change-induced shifts in precipitation patterns will also affect particulate matter, another potent air pollutant, consisting of both natural and anthropogenic sources, such as dusts, soils, acids, organic chemicals and metals (Fuzzi *et al.* 2015).

The rapidly changing climate affects plant growth and performance in both natural and managed ecosystems. Impacts of these changes and their multiple interactions on the functioning of plants have been studied for several decades and have been the topic of previous Special Issues of *Plant Biology* (Tausz *et al.* 2009; De Kok *et al.* 2016). Knowledge needed to predict the consequences of the rapid changes remains incomplete. Integration of fundamental molecular and physiological studies, combined with agronomic and ecological research, is essential to gain better insights into the responses of plants to a rapidly changing environment.

This Special Issue of *Plant Biology* includes a series of review articles and research papers addressing plant functioning in a changing climate in natural and managed ecosystems. Past, current and future trends in emissions of CO_2 and O_3 and the capacity of ecosystems to filter those are investigated in Ainsworth *et al.* (2020), while O_3 effects on plants in natural ecosystems are reviewed in Grulke & Heath (2020), including injury symptoms, effects on plant carbon, water and nutrient balance and growth. Effects of increasing atmospheric CO_2 are at the centre of two additional reviews. Focusing on agroecosystems only, especially in more extreme and highly variable growing environments, Tausz-Posch *et al.* (2020) review plant interactions with elevated atmospheric CO_2 where recently published experiments challenge long-held views. The role of water-use efficiency in driving terrestrial plant responses to global change, especially to increasing atmospheric CO_2, is reviewed by Cernusak (2020).

Combinations of multiple air pollutants are the focus of Papazian & Blande (2020), who review plant physiological responses and ecological perspectives in natural and managed ecosystems, including potential uses of plants to mitigate air pollution, whereas Korell *et al.* (2020) investigated the effects of drought and nitrogen deposition on the interactions of a root hemiparasite (*Rhinanthus alectorolophus*) with three host species. De Micco *et al.* (2020) analysed whether dust deposition can change leaf anatomical functional traits and the efficiency of the photosynthetic apparatus in *Centranthus ruber*.

Temperature effects on plant functioning are also addressed in this Special Issue. For example, Cochrane (2020) studied seed responses to warming in 20 woody perennials from the biodiverse Greenstone Belt of southern Western Australia, while Dewan *et al.* (2020) investigated the phenological and growth responses of seedlings of two key temperate tree species (*Fagus sylvatica* and *Quercus robur*) to temperature variation in the parental *versus* offspring generation. Heat-wave effects in combination with increasing atmospheric CO_2 on lentil (*Lens culinaris*) are investigated in Parvin *et al.* (2020). The role of small non-coding (snc)RNA in association with tolerance to low temperatures in a potato species (*Solanum commersonii*) is investigated in Esposito *et al.* (2020), providing useful information for a strategic use of genomic resources in potato breeding. Finally, the role of the CKB1 gene in *Arabidopsis thaliana* in regulating UV-B radiation stress signalling is elucidated in Zhang *et al.* (2020).

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