Geophysical Research Abstracts
Vol. 19, EGU2017-1651, 2017
EGU General Assembly 2017

Worldwide variation in within-canopy photosynthetic acclimation: differences in temporal and environmental controls among plant functional types

Ülo Niinemets (1) and Trevor Keenan (2)

(1) Estonian University of Life Sciences, Plant Physiology, Tartu, Estonia (ylo@emu.ee), (2) Climate and Ecosystem Science Division, Lawrence Berkeley National Lab., Berkeley CA 94720 USA (trevorkeenan@lbl.gov)

Major light gradients, characteristically 10- to 50-fold, constitute the most prominent feature of plant canopies. These gradients drive within-canopy variation in foliage structural, chemical and physiological traits. As a key acclimation response to variation in light availability, foliage photosynthetic capacity per area (Aarea) increases with increasing light availability within the canopy, maximizing whole canopy photosynthesis. Recently, a worldwide database including 831 within-canopy gradients with standardized light estimates for 304 species belonging to major vascular plant functional types was constructed and within-canopy variation in photosynthetic acclimation was characterized (Niinemets Ü, Keenan TF, Hallik L (2015) Tansley review. A worldwide analysis of within-canopy variations in leaf structural, chemical and physiological traits across plant functional types. The New Phytologist 205: 973-993). However, the understanding of how within-canopy photosynthetic gradients vary during the growing season and in response to site and stand characteristics is still limited. Here we analyzed temporal, environmental and site (nutrient availability, stand density, ambient CO_2 concentration, water availability) sources of variation in within-canopy photosynthetic acclimation in different plant functional types. Variation in key structural (leaf dry mass per unit area, MA), chemical (nitrogen content per dry mass, NM, and area, NA) and physiological (photosynthetic nitrogen use efficiency, EN) photosynthetic capacity per dry mass, Amass and area, Aarea) was examined. The analysis demonstrates major, typically 1.5-2-fold, time-, environment and site-dependent modifications in within-canopy variation in foliage photosynthetic capacity. However, the magnitude and direction of temporal and environmental variations in plasticity significantly varied among functional types. Species with longer leaf life span and low rates of canopy expansion or flush-type canopy formation had lower within canopy plasticity during the growing season and in response to environmental and site modifications than species with high rates of canopy expansion and leaf turnover. The fast canopy-expanding species that grow in highly dynamic light environments, actively modified Aarea by nitrogen reallocation among and partitioning within leaves. In contrast, species with low rate of leaf turnover generally exhibited a passive acclimation response with variation in Aarea primarily determined by light-dependent modifications in leaf structure during leaf growth. Due to limited reacclimation capacity in species with low leaf turnover, within-canopy variation in Aarea decreased with increasing leaf age in these species. Furthermore, the plasticity responded less to modifications in environmental and site characteristics than in species with faster leaf turnover. This analysis concludes that the rate of leaf turnover is the key trait determining the temporal variation and environmental responses of canopy photosynthetic acclimation.