Temperature influence of photosynthetic activity of *Ilex aquifolium* L.

- Photosynthetic advantage of climate change?

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Abstract

We test the effect of low temperatures on photosynthetic activity in *Ilex aquifolium* under field conditions. The ability to profit from photosynthesis in periods when deciduous trees are leafless and to take advantage of an extended growing season immediately, may favour *Ilex aquifolium* under contemporary climate change.

Introduction

Fig. 1: Current observed distribution of *Ilex aquifolium* and modelled distribution under moderate contemporary climate change, based on [1,2,3].

In the last decades *Ilex aquifolium* has expanded its range towards the north and northeast in Europe (Fig. 1). The range shift of *Ilex aquifolium* is regarded to be a response to recent climate change, particularly to rising winter temperatures [1]. Lethal and sublethal frost incidents have decreased, allowing *Ilex aquifolium* to spread beyond its historical range margin. In contrast to deciduous species, evergreens may photosynthesise during mild periods in the winter season. We here investigate how low temperatures affect the photosynthetic activity of *Ilex aquifolium*, the northernmost extending evergreen broad-leaved tree in Europe.

Methods

The sensitivity of the photosynthetic apparatus to cold stress was investigated by the means of chlorophyll fluorescence. Maximum quantum yield of photosystem II (F_v/F_m) of dark-adapted leaves and light-response of photosynthesis were determined under field conditions using a portable modulated fluorometer (PAM-2100, Walz). To test reversibility, leaves were transferred to the laboratory and exposed to room temperature for 2 hours before measurements were repeated.

Results

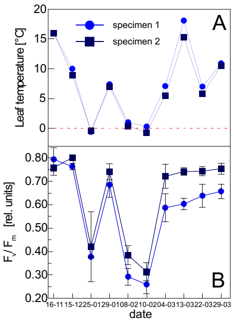

Fig. 2: Seasonal variations of leaf temperature (a) and maximum quantum yield of PSII (F_v/F_m) (b) measured *in situ* under field conditions during winter/spring 2006/07.

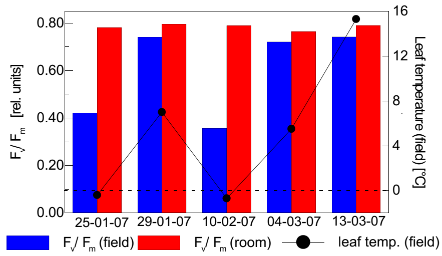

Fig. 3: Maximum quantum yield of PSII (F_v/F_m) measured under field conditions compared to measurements under room temperature two hours later.

Temperatures at freezing point reduced F_v/F_m up to 45% (Fig. 2). In the tested temperature range, the inhibition of photosynthesis that occurred at low temperatures was almost fully reversible within hours, when leaves were exposed to room temperature after measurements under field conditions (Fig. 3). Light-response of photosynthesis at different temperatures is shown in Fig. 4. The measured electron transport rates showed that *Ilex aquifolium* is able to perform photosynthesis on sunny, mild days also in winter and early spring.

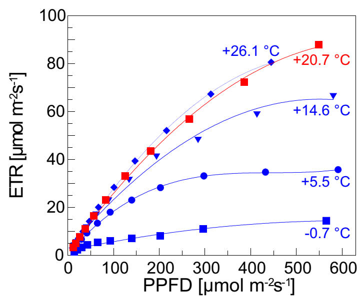

Fig. 4: Light-response curve of photosynthetic electron transport (ETR) of *Ilex aquifolium* under field conditions (blue) and room laboratory conditions (red) at different leaf temperatures.

Conclusions

Temperatures below the freezing point reduce photosynthetic activity of *Ilex aquifolium* considerably. However, within the tested temperature range during the mild winter 2006/07, this inhibition is reversible within hours. Hence, *Ilex aquifolium* may respond to favourable weather conditions within short time. The ability to immediately take advantage of an extended growing season and to profit from photosynthesis in periods when deciduous trees are leafless, may favour *Ilex aquifolium* under contemporary climate change.

References: [1] Walther, G.-R., Berger, S. & M.T. Sykes (2005): An ecological 'footprint' of climate change. Proc. R. Soc. B 272: 14271432. [2] Berger, S. (2003): *Ilex aquifolium* Bioindikator für Klimaveränderungen? Diplomarbeit. Institut für Geobotanik, Universität Hannover. [3] Rehse, A.-K. (2007): *Ilex aquifolium* Verbreitung und deren Grenzen im östlichen Deutschland. Diplomarbeit, Institut für Geobotanik, Universität Hannover.