Temperature Effects on the Photosynthesis by the Medicinal Plant Pinellia ternata Breit

EGUCHI, Toshihiko
Biotron Application Center, Kyushu University

TANAKA, Hiroyuki
Department of Chemo-Pharmaceutical Sciences, Kyushu University

MORIUCHI, Daichi
Daisen Co., Ltd.

YOSHIDA, Satoshi
Biotron Application Center, Kyushu University

他

出版情報：Environmental Control in Biology. 58 (2), pp.49-50, 2020-04-01. 日本生物環境工学会
バージョン：

Short Communication

Environ. Control Biol., **58** (2), 49-50, 2020
DOI: 10.2525/ecb.58.49

Temperature Effects on the Photosynthesis by the Medicinal Plant *Pinellia ternata* Breit.

Toshihiko EGUCHI[1], Hiroyuki TANAKA[2], Daichi MORIUCHI[3], Satoshi YOSHIDA[1] and Ken MATSUOKA[1]

[1] *Biotron Application Center, Kyushu University, Fukuoka 819−0395, Japan*
[2] *Faculty of Pharmaceutical Sciences, Sanyo-Onoda City University, Yamaguchi 756−0884, Japan*
[3] *Daisen Co., Ltd., Saitama 343−0002, Japan*

(Received October 28, 2019; Accepted November 20, 2019)

We investigated the effect of air temperature on the growth of the medicinal plant *Pinellia ternata* Breit. collected from the four prefectures, Fukushima, Kyoto, Nagasaki, and Okinawa prefectures. Plants were grown for 15 weeks in phytotrons controlled at air temperatures of 20, 25, and 30˚C. In the Kyoto lines, the highest corm yield was observed at 25˚C, whereas the corm yields in Fukushima, Nagasaki, and Okinawa lines did not differ significantly with respect to yield among the three growth temperature conditions. Therefore, in this study, the temperature effects on the photosynthesis by *P. ternata* collected from the three prefectures of Kyoto, Nagasaki, and Okinawa were investigated. Obvious effects of air temperatures were not observed in the plant photosynthesis for all regions. Thus, air temperature does not affect the yield through the photosynthesis in the *P. ternata.*

Keywords : growth temperature, photosynthesis, *Pinellia ternata*

INTRODUCTION

In our previous report, we had shown that the Kyoto line of the medicinal plant *Pinellia ternata* Breit. had the highest yield and effective ingredient content at a growth temperature of 25˚C (Eguchi et al., 2019). The Nagasaki line, however, did not show growth response at a temperature of 25˚C. We also investigated the effects of temperature on the growth and quality of the Fukushima and Okinawa lines (Eguchi et al., 2016); there was no obvious response to the growth temperature. Higher leaf photosynthetic capacity has been reported to contribute to higher yields in some crops (Jiang et al., 1988; Fischer et al., 1998; Higashide and Heuvelink, 2009; Takai et al., 2013). Therefore, we examined the temperature effects on the photosynthetic rate of the Kyoto, Nagasaki, and Okinawa lines.

MATERIALS AND METHODS

Plant material

Bulbils of *P. ternata* collected from three regions, namely, the Kyoto, Nagasaki, and Okinawa prefectures, were used for this experiment.

Cultural conditions

A porous solid material PUMICE® (grain size, 0.5−2.4 mm; porosity, 0.58; OhE Chemicals Inc., Osaka) was used as root medium and a commercial nutrient solution (OAT Agrio Co., Ltd., Osaka) adjusted to pH 4.0 was used. A 1/5000a Wagner pot was filled with the root medium up to 150 mm depth. Three pots for each of the three regions were placed in a plastic tray in which the nutrient solution was maintained at a depth of 9 cm. Pots were installed in three phytotrons at Kyushu University controlled at air temperatures of 25 and 30 ± 1˚C and relative humidity of 70 ± 5%. In each pot, three bulbils were planted with the bulbil base located 2 cm below the surface of the medium. Ground water levels were maintained at approximately 4 cm below the bulbil base, which is favorable for plant growth (Eguchi et al., 2014).

Measurement of photosynthetic rate

The photosynthetic rate of *P. ternata* was measured using a Li-6400XT portable photosynthetsis system (Li-cor, Nebraska, USA) at air temperatures of 25 or 30˚C and carbon dioxide at 400 ppm from 24−29, November, 2015. Simultaneously, the stomatal conductance of the plant was also measured using the same system at air temperature of 25˚C and carbon dioxide concentration of 400 ppm.

Statisitical analysis

Data for photosynthetic rate and stomatal conductance were analyzed using the analysis of variance ($n = 3$). The significant differences between regions or seasons were tested by Tukey test at $P < 0.05$.

RESULTS AND DISCUSSION

Figure 1 shows the photosynthetic rates of *P. ternata* at air temperatures of 25˚C and 30˚C under various light intensities. All the three lines did not show a significant

Corresponding author : Toshihiko Eguchi, fax: +81−92−802−4814,
e-mail: egut@agr.kyushu-u.ac.jp

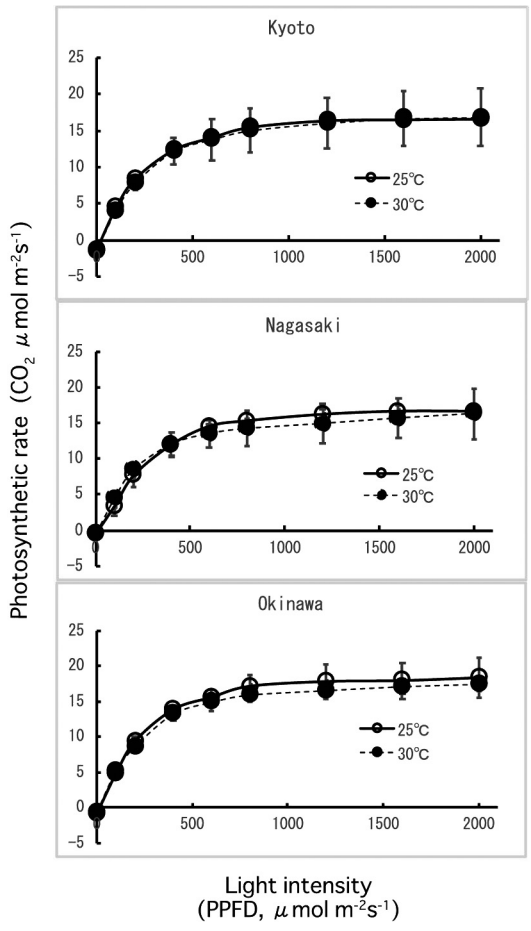

Fig. 1 Effect of growth temperature on the photosynthetic rate of *P. ternata* originated from three regions, Kyoto, Nagasaki, and Okinawa prefectures. Mean values are indicated. Vertical bars show standard errors (n=3).

difference between the two growth temperature conditions. In the Kyoto line, the corm yield and productiion of arabin, the effective ingredient (Maki et al., 1987), were significantly higher at 25˚C than at 30˚C (Eguchi et al., 2019). However, the photosynthetic rate curve of the Kyoto line at 25˚C was almost similar to the curve at 30˚C. At 25˚C air temperatures, 400 ppm CO_2, and 2500 μmol photon m^{-2} s^{-1} (PPFD), the photosynthetic rate and stomatal conductance did not differ among the three regions (data not shown).

The photosynthetic rate of the *P. ternata* responds to the rise in CO_2 concentration from 400 ppm to 800 ppm (Moriuchi et al., 2014); however, the rate does not respond to different air temperatures. Thus, the photosynthetic rate does not relate to the yield of *P. ternata.*

ACKNOWLEDGEMENT

This study was supported by JSPS KAKENHI Grant Number 24580371.

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