Effect of CO_2 Concentration on Net Photosynthetic Rate of *Coffea* ×*arabusta* Somatic Embryos Cultured Photoautotrophically©

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INTRODUCTION

Somatic embryos have been used for woody plant micropropagation. In *Coffea*, Afreen et al. (2001) showed that *C.* ×*arabusta* cotyledonary embryos had photosynthetic ability and could be cultured photoautotrophically (sugar-free culture) (Kozai, 1991). Therefore, application of photoautotrophic culture from the cotyledonary embryo stage through the rest of the production stages potentially shortens the transplant production period and enhances the establishment of transplants ex vitro as compared with photomixotrophic culture (sugar-containing culture). In this study, effect of CO_2 concentration on the net photosynthetic rate of *C.* ×*arabusta* somatic embryos was investigated to determine the environmental conditions for the photoautotrophic culture of somatic embryos.

MATERIALS AND METHODS

Ten cotyledonary embryos were cultured in each of three 22-ml vessels with MS medium and fibrous supporting materials (Florialite, Nisshinbo Ind. Inc., Tokyo). Cultures were placed for 36 d under 100 mmol $m^{-2}·s^{-1}$ PPF, 16-h photoperiod, 26°C air temperature, 75% relative humidity, and 1500 $mmol·mol^{-1}$ CO_2 concentration. The number of air exchanges of the vessel was 3.0 h^{-1}. On Days 0, 7, 14, 21, and 35 the vessels were sealed (0.05 h^{-1} number of air exchanges) and changes in CO_2 concentration inside the vessel (C_{in}) were recorded after it was adjusted to about 400, 3000, 8000, or 15,000 $mmol·mol^{-1}$. The net photosynthetic rate (P_n) and CO_2 compensation point (C_c) were estimated based on C_{in}, CO_2 concentration outside the vessels, vessel volume, CO_2 exchange rate of the medium (E_M), and number of air exchanges of the vessel. A rectangular-hyperbolic model was fitted for P_n to estimate the maximum P_n (P_m) and the CO_2 saturation point (C_s). E_M was estimated by measuring C_{in} for vessels without somatic embryos. C_s was estimated as the C_{in} that gave 95% of simulated P_m.

RESULTS AND DISCUSSION

On Days 0 and 7, P_n increased with increasing C_{in} but it was not saturated at the C_{in} examined. It was shown that effect of CO_2 concentration on P_n were different between Days 0 to 7 and 14 to 35. On Days 14, 21, and 35, the P_n was saturated and P_m was estimated as 0.09±0.004, 0.13±0.03, and 0.2±0.02 mmol per h per embryo, and C_s as about 5400, 3400, and 5000 $mmol·mol^{-1}$, respectively (Fig. 1). The C_c was about 100 $mmol·mol^{-1}$ on Days 14 to 35. Nguyen et al. (1999) also showed that photoautotrophic *C.* ×*arabusta* plantlets had high C_s (>5000 $mmol·mol^{-1}$). On Day 21, some somatic embryos had developed true leaves and 30% of somatic embryos had done so on Day 35. Increases in P_n and P_m with time observed in this experiment

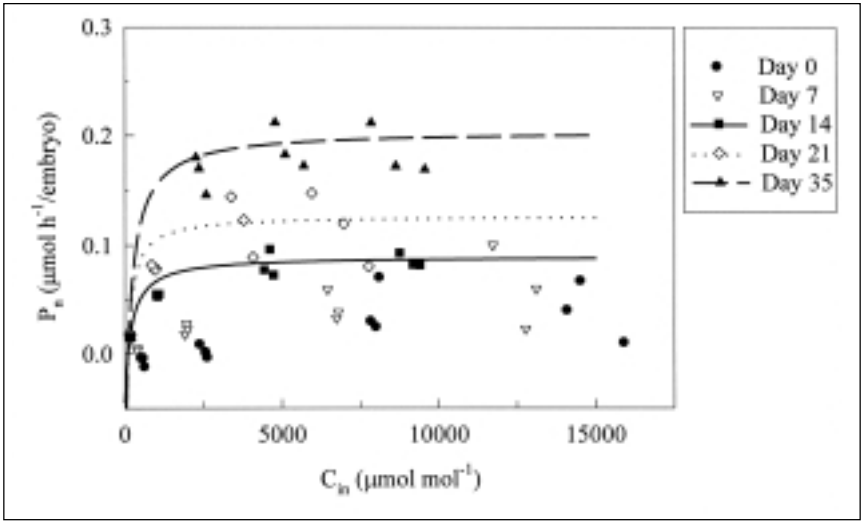

Figure 1. Net photosynthetic rate per somatic embryo (P_n) as affected by CO_2 concentration inside the vessel (C_{in}) on days 0, 7, 14, 21 and 35. All the somatic embryos on days 0, 7 and 14 were in the cotyledonary stages. Data on days 14, 21 and 35 were fitted with the model $P_n=P_m \cdot (C-C_c)/(K+(C-C_c))$.

were due to the growth and development of somatic embryos. Results suggest that photoautotrophic growth and development of the somatic embryos will be promoted by maintaining C_{in} at 3000 to 5000 mmol·mol^{-1}.

LITERATURE CITED

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