ORCHID RESPONSES TO SUPER-HIGH ATMOSPHERIC CO2 ENRICHMENT

Background
The authors write that "the genus Cymbidium comprises about 50 species distributed in tropical and subtropical Asia and Oceania," and that "almost all cultivated cymbidiums are hybrids, thin-leaved and with a C3 mode of photosynthesis." In addition, they say that "Cymbidium was the first orchid genus to be propagated using shoot-tip culture."

What was done
Cymbidium (Music Hour 'Maria') shoots with two to three leaves that had been obtained from a mass of protocorm-like bodies derived from shoot-tip culture were further cultured in vitro on modified Vacin and Went medium in air augmented with either 0, 3000 or 10,000 ppm CO2 under photosynthetic photon flux densities of either 45 or 75 µmol m^{-1} s^{-1} that were provided by cold cathode fluorescent lamps for a period of 90 days, after which they were transferred to ex vitro culture for an additional 30 days.

What was learned
Relative to plants grown in vitro in ambient air, the percentage increases in shoot and root dry weight due to enriching the air in which the plants grew by 3000 ppm CO2 were, respectively, 216% and 1956% under the low light regime and 249% and 1591% under the high light regime, while corresponding increases for the plants grown in air enriched with an extra 10,000 ppm CO2 were 244% and 2578% under the low light regime and 310% and 1879% under the high light regime. Similarly, in the ex vitro experiment, percentage increases in shoot and root dry weight due to enriching the air in which the plants grew by 3000 ppm CO2 were, respectively, 223% and 436% under the low light regime and 279% and 469% under the high light regime, while corresponding increases for the plants grown in air enriched with an extra 10,000 ppm CO2 were 271% and 537% under the low light regime and 332% and 631% under the high light regime.

What it means
The four Japanese researchers conclude that "super-elevated CO2 enrichment of in vitro-cultured Cymbidium could positively affect the efficiency and quality of commercial production of clonal orchid plantlets."

Reference
Norikane, A., Takamura, T., Morokuma, M. and Tanaka, M. 2010. *In vitro growth and single-leaf photosynthetic response of Cymbidium plantlets to super-elevated CO2 under cold cathode fluorescent lamps*. **Plant Cell Reports 29**: 273-282.

EFFECTS OF ELEVATED CO2 ON A TROPICAL ORCHID

What was done
The authors grew the epiphytic CAM [*] orchid Mokara Yellow in controlled environment chambers receiving atmospheric CO2 concentrations of 380 and 760 ppm for two months to study the effects of elevated CO2 on plant growth and enzyme functioning. [Mokara is an intergeneric species: Mokara (Arachnis × Ascocentrum × Vanda)]

What was learned
The elevated CO2 concentration increased the relative growth rate of the orchids by 25%. As a result, the CO2-enriched plants produced 31% and 98% more shoot and aerial-root dry mass, respectively, than their ambiently-grown counterparts. At the biochemical level, elevated CO2 reduced rubisco ["] activity during the light period, but significantly stimulated PEPcarboxylase ["] activity during the dark period.

Also, the activities of SPS (sucrose-phosphate synthase, a key regulatory enzyme involved in partitioning carbon between sucrose and starch in leaves) and SS (sucrose synthase) were significantly increased by atmospheric CO2 enrichment. Finally, elevated CO2 increased the concentrations of several plant hormones in leaf and aerial root tips by as much as 21-fold.

What it means
As the CO2 content of the air increases, this particular orchid, and perhaps other plants that utilize CAM metabolism, will likely exhibit significant increases in growth and dry matter production as a result of optimization of resources at the enzymatic level within plant organs. Indeed, the nocturnal CO2-induced increase in PEPcarboxylase should significantly increase carbon uptake, while the similarly-induced increases in SPS and SS should enhance the mobilization and utilization of photosynthetically-derived sugars, preventing or reducing their accumulation in leaves and, therefore, eliminating or reducing feedback inhibition of carbon assimilation. Thus, one can anticipate greater and more robust growth by Mokara Yellow orchids, and perhaps other CAM plants as well, as the air's CO2 content continues to rise.

[* Note: CAM plants
Plants that close their stomata during the day to reduce water loss and open them at night for carbon uptake. PEP carboxylase nocturnally fixes carbon into a four-carbon compound that is accumulated within vacuoles. During the day, this compound internally releases carbon dioxide, which is then refixed using rubisco.

This phenomenon also effectively inhibits carbon loss by photorespiration. Only about 3 to 4% of earth's plant species can be characterized as CAM plants.