Carbon Dioxide Enrichment Technique for Lowlands Controlled Environment System

Vegetables growing under controlled environment (CE) of simple plastic-covered rainshelters (RSP) in Malaysian lowlands has proven to be commercially viable and thus has a great economic potential. Studies indicated substantial yield increase with high quality and chemical free harvests. Since the nineties, however, production has denoted a leveling off with little improvement in crop productivity. With the government's call to increase domestic food production in order to reduce food import bills, a technology alleviation to enhance crop production and productivity was developed by bringing the crop closer to its photosynthetic potential, through carbon dioxide (CO_2) enrichment or fertilization. The positive response of many important agricultural crops to CO_2 enrichment has been well-documented. In the temperate, CO_2 enrichment for food crop production under CE system is a common practice; however a complete adoption of the available technology from the temperate would not be applicable for humid tropical conditions mainly due to the "greenhouse effects" versus the "oasis effects of temperate area. In hot and humid climates, increase in ambient temperature to about 8–15 ^oC is a common feature under greenhouses and RSP.

With the recent development a growth house (GH) prototype, equipped with heat dissipation and gas containment capabilities, the establishment and development of a practical CO_2 fertilization technique for annual crops and seedling management of perennial crops were made possible. As observed, both additional shading and effective ventilation managed to lower and maintain the ambient temperatures to about similar values of the opened condition with ± 1 ^oC, whilst maintaining liquid temperatures of the stagnant hydroponics within a range of 26 ± 3 ^oC. The strategic enrichment technique at four levels viz. ambient ≈ 350 ppm (as a control), 750 ppm (2-fold CO_2), 950 ppm (3-fold CO_2) and 1150 ppm (4-fold CO_2) imposed on to 7-day *Brassica chinensis* var. *chinensis* seedlings were also made possible. This resulted in earlier maturity by almost 10 days, increased leaf area and biomass by about 20% and 50%, respectively. This is implicated by the increase in RuBP carboxylation efficiency, apparent quantum yields and relative SPAD reading for relative chlorophyll content, especially in the 3x elevated CO_2 condition as compared to the non-enriched treatment. Better quality produce of uniform green color and prolonged shelf life (14 d without refrigeration) were also observed. Enhanced crop maturity under enriched GH may also open an opportunity to raise difficult to flower/fruit plants and advanced planting materials, which may partly solve the problem of juvenility, and possibly speeding up accumulated early harvest. Observations on oil palm CO_2-enriched seedlings indicated increased photosynthetic rate (≅ 12 folds) as attributed to higher intercellular CO_2 level (C_i), increased both stomatal conductance and transpiration (≅ 3 folds), and water-use-efficiency (WUE ≅ 4 folds) as compared to the control. Hence, CO_2 enrichment technique for the tropical lowlands under the GH prototype controlled environment is technically feasible and has a great application potential in the seedling/nursery industry (plugs, transplants, advanced planting materials), in production research and development study, and in the climate change impact analyses for possible enhanced bioproductivity and income generation.

Plate 1. Development of the growth house prototype with CO_2 capability and minimal 'greenhouse effects' and fitted with CO_2 gas delivery and monitoring system

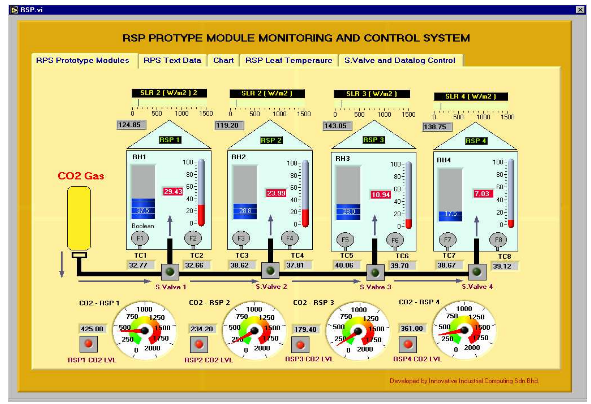

Plate 2. Computer interfaced microclimate data acquisition system using a software dedicated for CO_2 control.

Plate 3. Increased biomass of *Brassica* by 40% when introduced with CO_2 enrichment technique at 1150 ppm (left) versus a non-enriched control plot (right) at 4 weeks after treatment

Plate 4. Extensive root growth by about 50% resulted from CO_2 enrichment technique (left) versus slow root growth in the non-enriched control plot (right) at four weeks after treatment