City as the final stop via large farms in Tokachi Plain. In the evening, of course, we held a goodbye party together with two supporters.

The Fourth Day (12 September 2004). During this day, we visited several famous sightseeing spots such as Kushiro Marshland, Fogged Mashu Lake, and Sulfur Mountain. Although the weather conditions on last day were not always good, everybody seemed to enjoy this post-tour.

Lastly, I wish for your continued health, happiness, and second coming to Hokkaido.

A Plant-Growing Apparatus for Producing CO_2-Dissolved Water©

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INTRODUCTION

In this paper, we are introducing a plant-growing apparatus for producing the highly concentrated gas-dissolved water suitable for plant growth (Fig. 1). The plant-growing apparatus is characterized by: (1) a step of supplying CO_2 or O_2 in a pressurized state from one side separated with a permeable membrane (a hollow fiber membrane) that is permeable only to a gas and impermeable to a liquid, while causing water to flow to the other side of the permeable membrane; (2) a step of dissolving the CO_2 or O_2 in the water so as to reach a predetermined concentration in water; and (3) a step of intermittently supplying (atomizing and/or irrigating) CO_2- or O_2-dissolved water to plants, thereby promoting plant growth.

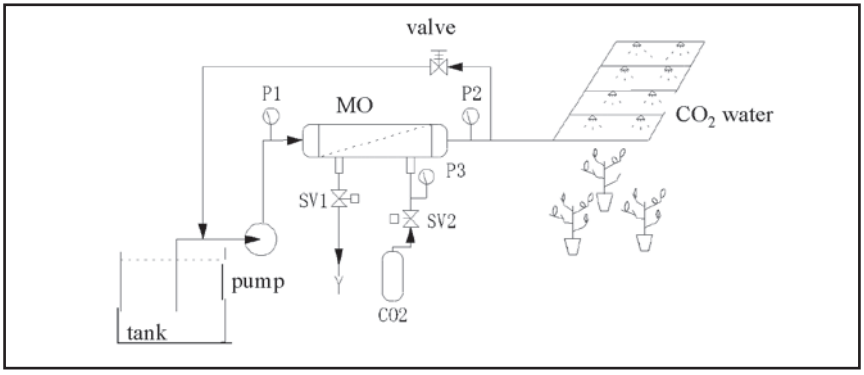

Figure 1. A view showing an example of plant-growing apparatus in the present paper. The apparatus is roughly made up of, from the upstream side, a water tank, a pressure pump, a hollow fiber membrane module MO, a CO_2 gas cylinder, a control valve SV2, and a relief valve. Operations of the entire apparatus are controlled by a control unit (not shown).

MATERIALS AND METHODS

Hollow filter membrane (MHF) (three-layer composite hollow fiber) module was used as the hollow fiber membrane module. Carbon dioxide-dissolved water (2,200 µmol·mol^{-1} CO_2) was sprayed in mist form onto kenaf (*Hibiscus cannabinus* L.) plants being illuminated with light (light 14 h, dark 10 h, 24 °C) at intervals of 30 min and for 60 sec at a time during the light period for 47 days. Tap water (as control water) instead of CO_2-dissolved water was sprayed in the same way and compared.

RESULTS AND DISCUSSION

The results are shown in Table 1 and Fig. 2.

The growth of kenaf was promoted when a high concentration of CO_2-dissolved water was intermittently atomized onto the plant. Similar results were obtained from CO_2-dissolved water irrigation with *Eucalyptus* plants.

The plant-growing method and plant-growing apparatus that use various highly concentrated gases dissolved in water according to the present paper could be applied widely to the fields of agriculture and forestry.

Table 1. Effects of CO_2-dissolved water (2,200 µmol·mol^{-1} CO_2) on growth of kenaf (*Hibiscus cannabinus*) on plants sprayed at intervals of 30 min and for a duration of 60 sec at a time during the light period (light 14 h, dark 10 h, 24 °C) for 47 days (n = 10, data are the average ±SE). SPAD-values were measured with a chlorophyll meter SPAD-502 (Konica Minolta Sensing, Inc. Japan).

Treatment (N = 10)	Dry wt. (g)	Height (cm)	Leaf size (cm)	SPAD
Water (control)	1.49±0.57	30.9±6.9	5.7±0.7	43.6±6.9
CO_2 water	2.86±0.81	46.7±10.8	7.0±0.7	47.4±3.1
t-test 1% level	**	**	**	

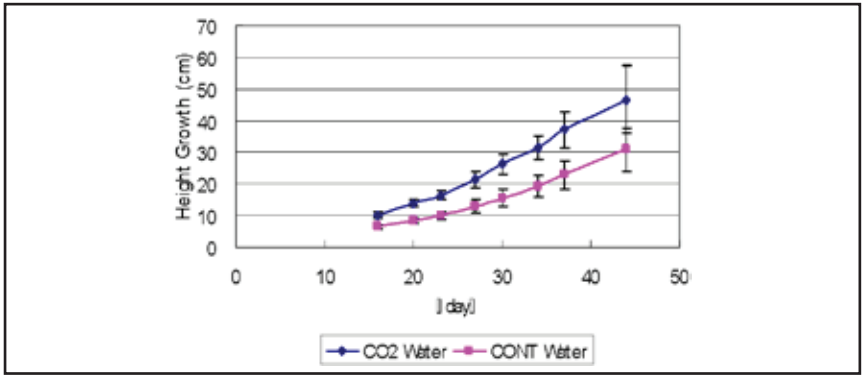

Figure 2. Growth curve of kenaf (*Hibiscus cannabinus*) plants sprayed with CO_2-dissolved water (2,200 µmol·mol^{-1} CO_2) and tap water as a control at intervals of 30 min and for a duration of 60 sec at a time during the light period (light 14 h, dark 10 h, 24 °C) for 47 days (n = 10, data are the average ±SE).