

## EFFECT OF ENRICHED CO<sub>2</sub> ON RICE UNDER OPEN TOP CHAMBER (OTC) CONDITION AT KHUMALTAR

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### ABSTRACT

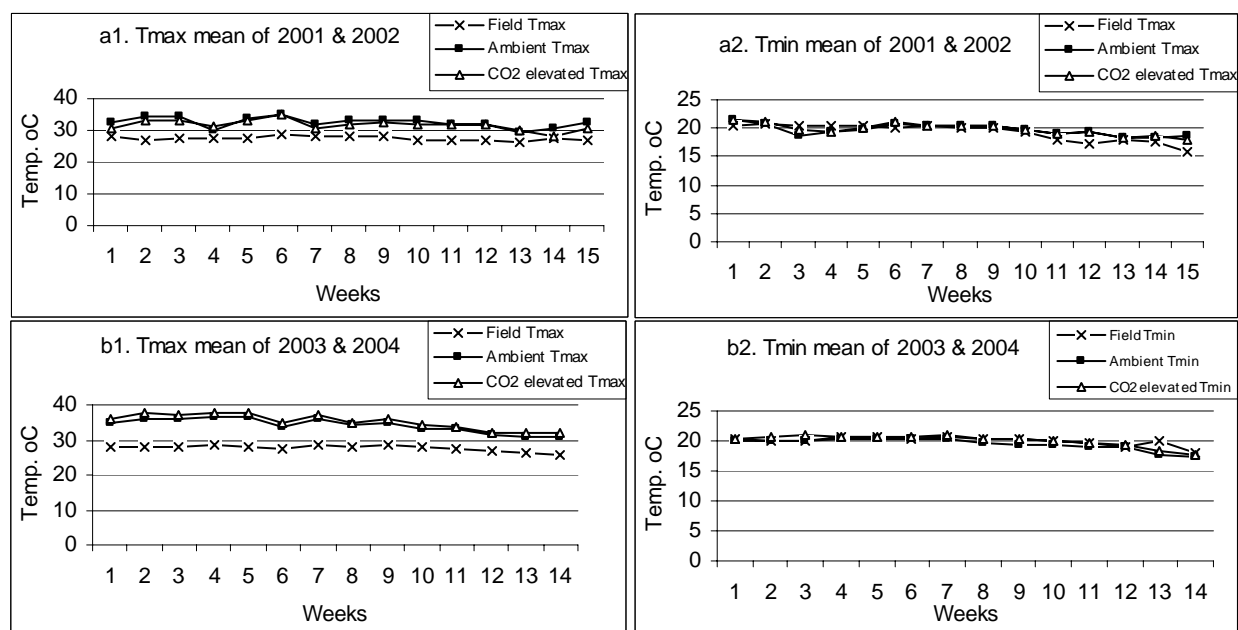
The effect of CO<sub>2</sub> enrichment in raising the temperature was realized in the Open Top Chamber (OTC) experiment. The elevated CO<sub>2</sub> with this level of temperature raised grain yield and yield components of rice but varied greatly by year. The CO<sub>2</sub> enriched plot had lesser N, P, and K in grain, straw, and root but higher organic carbon (OC) in the root compared to the Ambient and the Field. The study indicated that this rise of temperature due to the elevated CO<sub>2</sub> could not adversely affect the yield.

### INTRODUCTION

Rice is the most important food crop contributing almost 20 percent of the Agriculture Gross Domestic Product of Nepal. The major works on CO<sub>2</sub> enrichment studies on various crops and other living plants had been conducted in USA [Hunsakar, *et al.*, 1996; Idso *et al.*, 1987; Kimbal, 1983] and some in India [Upreti, 1998]. Those studies showed that the yield increased with the elevated CO<sub>2</sub> concentration. The CO<sub>2</sub> is a greenhouse gas, which enhances the photosynthetic rate, soil organic matter, water use efficiency, reduces the stomata opening and ultimately, increases the net primary production. However, the simultaneous rise in the temperature could adversely affect those processes and the yield. This study was conducted from 2001 to 2004. The objective was to assess the effect of elevated CO<sub>2</sub> on rice yield under the fabricated Open Top Chamber (OTC) condition at Khumaltar (1350 m), Lalitpur, Nepal. A popular Japonica hill rice variety "Chainung-242" was used. The CO<sub>2</sub> was enriched to a level of 550 to 600 ppm.

### RESULTS AND DISCUSSION

In 2001 and 2002, the ambient chamber was not air circulated through the polythene pipe. The maximum temperature (Tmax) remained lower by 0.70 °C in the CO<sub>2</sub> enriched than the Ambient but higher than the Field plot (Fig. 1a<sub>1</sub>). The minimum temperature (Tmin) on the other hand was found slightly higher in CO<sub>2</sub> enriched plot (Fig. 1a<sub>2</sub>). Because, the air circulation was stopped in the OTC system during night which caused to raise the Tmin in the CO<sub>2</sub> enriched plot. Realizing this, it was later corrected in 2003 and 2004 by replicating the installation of the 6" polythene pipe as in the CO<sub>2</sub> enriched chamber in order to blow air as in the CO<sub>2</sub> chamber. After the correction, due to the CO<sub>2</sub> enrichment, the average Tmax and Tmin over the Ambient in 2003 and 2004 rose by 1.30 °C and 0.56 °C, respectively (Fig. 1b<sub>1</sub> and 1b<sub>2</sub>).



**Fig. 1.** Maximum and minimum temperature trends during the rice growing seasons

**Table 1.** Grain Yield (Gyld) and % Change during 2001, 2002, 2003 and 2004

Treatment	2001		2002		2003		2004	
	Gyld Kg/ha	Change %	Gyld Kg/ha	Change %	Gyld Kg/ha	Change %	Gyld Kg/ha	Change %
CO <sub>2</sub> enriched	10857	70.0	11966	15.8	9861	45.14	8917	26..9
Ambient	6860	7.4	11392	10.2	9395	38.28	8110	15.4
Field	6386	0.0	10334	0.0	6794	0.0	7028	0.0

**Table 2.** Phenology (Days after Seeding) during 2001, 2002, 2003 and 2004

Treatment	Panicle Initiation				Heading				Physiological Maturity			
	2001	2002	2003	2004	2001	2002	2003	2004	2001	2002	2003	2004
CO <sub>2</sub> enriched	40	43	41	45	66	73	62	66	100	104	98	106
Ambient	40	45	42	47	63	70	64	68	100	102	99	108
Field	42	45	45	52	67	72	66	70	102	103	104	112

**Table 3.** Grain, Straw, and Root Analysis for N and OC during 2002 and 2004

Treatment	Grain				Straw				Root			
	N %		OC %		N %		OC%		N %		OC %	
	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004	2002	2004
CO <sub>2</sub> enriched	1.47	1.04	5.82	8.76	1.06	0.61	19.77	16.97	0.94	0.95	16.06	24.27
Ambient	1.80	1.17	5.26	7.53	1.23	0.50	20.48	17.65	1.14	1.07	14.94	23.46
Field	1.47	0.77	6.38	6.38	1.78	0.60	21.95	19.05	2.04	0.82	14.19	23.46

The grain yield in the CO<sub>2</sub> enriched chamber increased by 62.6 % in 2001 but in other years by 5.6 % to 11.5 % over the Ambient and by 15.8 % to 45.14 % over the Field (Table 1). The first year variation could have been due to the bios-management practice at the start. Similarly, straw and root yield and other yield components like tillers and grain numbers were also found higher in the CO<sub>2</sub> enriched plot (Table not shown here). Tiller numbers were the most influencing yield component to cause yield differences. But the kernel weight was little influenced. Higher leaf area index and plant height contributed to the greater straw yield. The phenological events panicle initiation, flowering and physiological maturity enhanced slightly due to the OTC fabrication but were not significant (Table 2). The CO<sub>2</sub> enriched plot had lesser N, P and K contents in grain, straw and root, however, the OC content in the root was a bit higher but non-significant (Table 3). The study indicates that the temperature gain by an average of 1.30 °C and 0.56 °C due to the elevated CO<sub>2</sub> was not the factor that could adversely affect the rice yield, which seemed to be agreeing with the model prediction [Sherchand, 2003].

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