EFFECT OF ELEVATED CO_2 ON GROWTH, BIOMASS PRODUCTION AND PHOTOSYNTHESIS OF PANICUM MAXIMUM AND STYLOSANTHES HAMATA UNDER SEMI ARID TROPICS

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ABSTRACT

In *P. maximum* the cumulative dry biomass production in two cuttings showed an increase of 59.24% and 43.17% in open top chambers (OTC) with elevated CO_2 (600±50 ppm) (C_{600}) and without elevated CO_2 (C_{OTC}) respectively over the open field grown corps (Ca). In *S. hamata* the dry matter increased by 39.79% under C_{600} and 31.02% in C_{OTC} over Ca. The canopy photosynthesis (P_N x LAI) increased significantly in both the crop species with elevated CO_2. The increased rate of canopy photosynthesis indicated that there was higher assimilation of CO_2, which has intern maximum biomass production. The increase in fresh and dry matter accumulation in C_{600} indicating that these crop species should be promoted for higher biomass production and carbon sequestration in the semi arid tropical environmental conditions.

INTRODUCTION

Increased atmospheric CO_2 concentration and associated global warming are expected to alter growth rates and competitive relationships in pasture crops. Many studies have been conducted in fully controlled environment but there is need to take such type of experiments in the natural field conditions where realistic diurnal and seasonal temperature and radiation fluctuation occur. There have been a few studies on the effects of elevated CO_2 on fodder crops [*Gorisson and Cotrufo* 2000, *Morgan et al.,* 2001]. Forage species particularly perennial grasses cover large area and serve an important role as sinks for atmospheric CO_2. *Panicum maximum* (C_4) and *Stylosanthes hamata* (C_3) has been studied as a response to elevated CO_2 (600±50 ppm) on their growth and productivity in the Open Top Chambers with or without elevated CO_2 in semi arid tropics.

METHODOLOGY

Thirty days old seedlings of *P.maximum* Jacq. was transplanted in side the OTCs without and with elevated CO_2 (600 ±50 ppm) and in open field on the onset of monsoon. The *S. hamata* (L.) Taub, seeds were sown at the time of transplanting of grasses in OTCs and in open field. Recommended agronomical practices were applied to grow the crop. In C_{600} the flow of the CO_2 gas was adjusted by flow meter to get the exact concentration of CO_2. The periodical monitoring of CO_2 inside the chamber was done by using IRGA. The rate of photosynthesis of the fully expanded second leaf was measured at the 50% flowering stage of the crop with a portable photosynthesis system LI-6200 (LICOR, USA). Growth characters like plant height; leaf area, specific leaf weight and biomass were measured by the sampling done from $1m^2$ area of each chamber as well as the open field.

RESULTS AND DISCUSSION

The *P. maximum* (C_4) and *S. hamata* (C_3) responded significantly to its growth performance and biomass production. In *P. maximum* the main tiller height increased to 234.5 cm under C_{600} as compared to Ca i.e. 168.8 cm in first cutting. The leaf area index (LAI) increased to 1.7 times under elevated CO_2 over the control (5.10). SLW were also influenced under the elevated CO_2. The fresh and dry biomass production was recorded higher in the first cut as compared to the second cut of the crop. The cumulative fresh biomass production of two cuttings increased by 61.25% under C_{600} and 49.51% in C_{OTC} over the open field grown crops (Fig 1A). The dry matter accumulation was also increased to the tune of 59.24% under elevated CO_2 and 43.17% under C_{OTC} over the open field grown corps. The rate of photosynthesis (P_N) and stomatal conductance (CS) increased under elevated CO_2 over open grown crops (Table 1) indicating the positive influence of elevated CO_2 on CO_2 assimilation of this crop.

The rate of transpiration (TR) increased in the C_{600}. The P_N/TR ratio, which indicates the photosynthetic water use efficiency, has not shown any remarkable variation in the crops grown under these environmental conditions. The decrease in P_N/CINT may be due to increase in intercellular CO_2 concentration. The canopy photosynthesis (P_N X LAI) increased by 40.77% under C_{600} and 28.13% in C_{OTC} over the open field grown crops (Table 1).

In *S. hamata* the plant height increases significantly as the crop grown under C_{600} (117 cm) over the Ca (91.33 cm). The specific leaf weight was decreased slightly in OTC with or with out elevated CO_2.

Table: 1. Effect of elevated $CO_{2\ on}$ physiological characters.

Treatment	P_N (µ moles $m^{-2}s^{-1}$)	Cs (mol $m^{-2}s^{-1}$)	TR (µmoles m^2s^{-1})	P_N /TR	P_N / CINT	P_N X LAI
P. maximum						
OPEN	19.21	0.164	8.24	2.33	0.086	97.97
OTC	22.42	0.202	9.42	2.38	0.105	181.62
OTC+CO_2	24.26	0.212	10.63	2.28	0.057	219.06
CD at 0.05p	4.635	0.024	1.26	-	-	-
S. hamata						
OPEN	13.02	2.266	10.214	1.275	0.052	40.39
OTC	15.13	2.463	8.979	1.685	0.045	75.74
OTC+CO_2	20.49	1.794	9.519	2.153	0.047	114.93
CD at 0.05p	4.490	0.245	1.439	-	-	-

The LAI was recorded to 5.609 in the plants grown under C_{600} over Ca (3.102). The increase in fresh biomass was 39.33% in C_{600} and 23.06% in C_{OTC} and the dry matter increase was to the tune of 39.79% under C_{600} and 31.02% in C_{OTC} over the open field conditions (Fig 1B). The increase in biomass under C_{600} indicating that being the C_3 legume it has responded significantly and therefore, this species can be promoted for higher biomass production and carbon sequestration in the semiarid tropics. Steady increase of dry matter is a common physiological response to high CO_2 concentration [*Atkinson et al* 1997]. The increase in photosynthetic rate was to the tune of 36.45% and 13.95% under C_{600} and C_{OTC} respectively over Ca. The canopy photosynthesis increased up to 64.86% with elevated CO_2 over the control (Table 1). The rate of transpiration decreased slightly in $C_{600.}$ The stomatal conductance decreased significantly in C_{600}. The P_N/TR which indicates the photosynthetic water use efficiency increased significantly with the higher value (2.153) in C_{600} followed by C_{OTC} (1.685) and Ca (1.275) indicating the interacting effect of high level CO_2 in the efficient utilization of water for the higher productivity (Table 1). The data revealed that the intrinsic water use efficiency of this C_3 crop improved significantly under elevated CO_2 and the plants can sustain the productivity under higher level of CO_2 and warmer environmental condition.

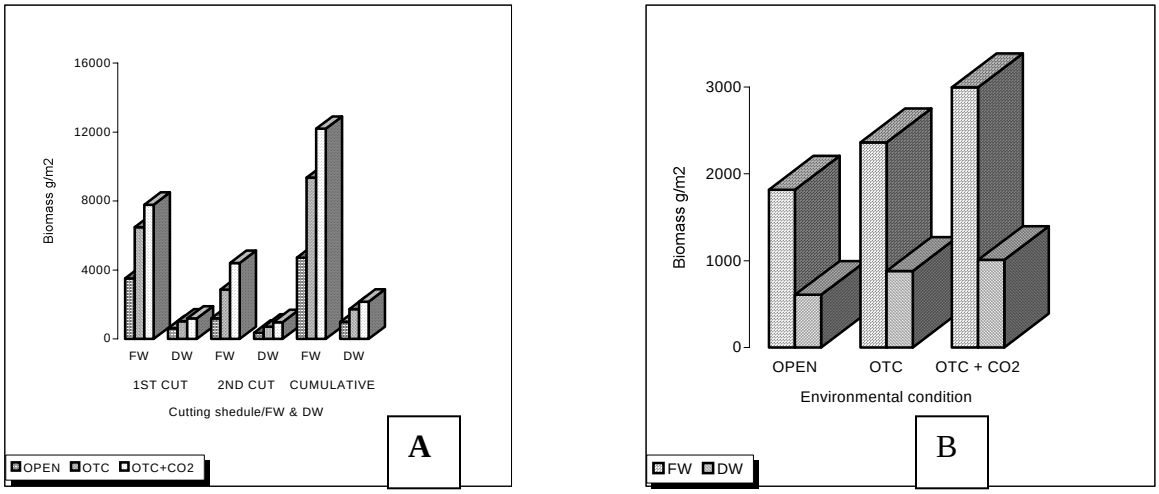

Fig. 1. Biomass production in *P. maximum* (A) and S. *hamata* (B) with or with out elevated $CO_{2.}$

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