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Fruits, seeds at elevated co2 in cotton & tur in Nagpur district

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Abstract
There is a significant impact of elevated CO_2 on the N concentration of plant tissues and present data to support the hypothesis that reductions in the quality of plant tissue commonly occur when plants are grown under elevated CO_2. To study response of plants in high CO_2 and other gas in environment with precise control and regulation of desired CO_2, temperature and humidity inside the Open Top Chambers. Open Top Chambers is an innovative and cost-effective approach to investigate effects of elevated CO_2, Temperature and humidity on the growth dynamics and yield response of plants. In this approach CO_2 gas is supplied to the chambers through CO_2 gas cylinders and maintained at the set levels using manifold gas regulators, pressure pipelines, solenoid valves, sampler, pump, CO_2 analyser, PC linked supervisory control ad data acquisition (SCADA). The different conditions used for the experiment are as follows: AMB: Ambient Outside, OTC1: Ambient $C0_2$ (Control), OTC2: Elevated $C0_2$ (450ppm) + Ambient Temp, OTC3: Elevated $C0_2$ (500 ppm) + Ambient Temp, OTC4: Elevated $C0_2$ (550ppm) + Ambient Temp. Thus, on the basis of the study results, it is concluded that there is noticeable change in the number of fruits on Cotton, and Tur crops in the study area.

Keywords: OTC, elevated CO_2, ambient, cotton, tur

Introduction

At the beginning of the 21st century, we are faced with a rapid change in the environment. Greenhouse forcing is expected to alter temperature and rainfall patterns and atmospheric CO_2 concentration will continue to increase for an extended period of time. There can be no doubt that under future conditions, agro-ecosystems and their management will substantially differ from today and potential ozone impacts in the agricultural sector will depend largely on changes in other factors. Hence, the evaluation of future trends in ozone impacts cannot rely solely on trends in ground-level ozone concentrations predicted by atmospheric global climate change, caused by increased emissions of greenhouse gases, is likely to affect agroecosystems in many ways, but the outcome, for instance, as a shift in productivity, depends on the combined effects of climate (temperature, precipitation) and other global change components.

Once environment and diseases are closely related, climate change will probably alter the geographical and temporal distribution of phytosanitary problems. The host plant agroclimatic zoning for coffee will be altered, as showed by Assad *et al.* (2004) [1]; likewise, pathogens and other microorganisms related to the disease process will be affected. Therefore, new diseases may arise in certain regions and other diseases may cease to be economically important, especially if the host plant migrates into new areas (Coakley *et al.*1999) [2].

Disease simulation models frequently used for forecasting can be utilized in simulation studies of spatial and temporal distribution in future climate scenarios. For vector-transmitted pathogens the risk analysis may include the effects of climate change on the vector population, as discussed by Harrington (2002) [3] for the barley yellow dwarf disease.

Using mathematical models, Carter *et al.* (1996) [4] simulated climate change in Finland and concluded that warming will expand the cropping area for cereals by 2050 (100 to 150 linear km per Celsius degree increase in mean annual temperature); furthermore, higher yields are expected with higher CO_2 concentration. In this scenario, potato cropping will also be benefited with an estimated 20 to 30% increase in yield.

Thomas and Strain (1991) [3] reported that the main effect of CO_2 enrichment was to triple the number of branches and to increase total branch length six times. Enhanced and accelerated branching also increased total leaf area 50% at elevated CO_2 concentrations.

Atmospheric CO_2 is the sole carbon source for plants. Current levels of CO_2 limit CO_2 assimilation in C_3 crops and increasing CO_2 concentrations up to 800–1000 ppm stimulate photosynthesis (Amthor, 2001) [6]. However, stimulation of photosynthesis does not directly translate in increased biomass, or yield. In determinate crops such as cereals, grain yield not only depends on photosynthesis but also on the length of the active phase of leaf photosynthesis and the sink capacity of the grains. Fangmeier *et al.* (2000) [7] found that in barley (*Hordeum vulgare*, L.), elevated CO_2 increased the nitrogen (N) sink capacity of the grains in combination with accelerated flag leaf senescence, which, in turn, reduced the length of the period of photosynthetic carbon acquisition.

Cotrufo *et al*., (1998) [8] studied the impacts of elevated CO_2 on the N concentration of plant tissues and present data to support the hypothesis that reductions in the quality of plant tissue commonly occur when plants are grown under elevated CO_2. Synthesis of existing data showed an average 14% reduction of N concentrations in plant tissue generated under elevated CO_2 regimes.

Material Methods

To study response of plants in high CO_2 and other gas in environment with precise control and regulation of desired CO_2, temperature and humidity inside the Open Top Chambers. Open Top Chambers is an innovative and cost-effective approach to investigate effects of elevated CO_2, Temperature and humidity on the growth dynamics and yield response of plants. In this approach CO_2 gas is supplied to the chambers through CO_2 gas cylinders and maintained at the set levels using manifold gas regulators, pressure pipelines, solenoid valves, sampler, pump, CO_2 analyser, PC linked supervisory control ad data acquisition (SCADA). The data generated by Open Top Chambers are more realistic for impact assessment analysis of rising atmospheric CO_2 and temperature on plants for developing models to predict the responses for future climatic conditions. The accuracy of the result depends on the system adopted and its maintenance of the required CO_2 levels with near natural and variable conditions for other parameters. Four units of Open Top Chambers for elevated CO_2 study were available with high quality multi-layered polycarbonated sheets (4mm thickness) of 3X3X4 mt. dimensions with GI/MS structure with proper foundation and grouting. A suitable door of 6X3 ft size is provided in each chamber. Multi-layered clear polycarbonate sheet with 80-85% light transmission level is used for Open Top Chamber structure. Flat and angle aluminium and rust-free screws are used for mounting of polycarbonate sheet. Welding at four corners and inclination of 30 degree at the top is provided to protect against high winds and moderate vibrations. Sealing of Open Top Chamber is achieved using aluminium angles plates at the top, corners and centre along with gaskets. Door is sealed using U type gaskets with overlapping of sheets to prevent loss of CO_2. The different conditions used for the experiment are as follows

AMB: Ambient Outside

OTC1: Ambient $C0_2$ (Control)

OTC2: Elevated $C0_2$ (450ppm) + Ambient Temp

OTC3: Elevated $C0_2$ (500 ppm) + Ambient Temp

OTC4: Elevated $C0_2$ (550ppm) + Ambient Temp

All the data generated was analysed using appropriate statistical tests with the help of PASW 18.0 software (formerly known as SPSS 18.0). The descriptive statistics like mean, standard deviation, minimum, maximum, etc. were determined from the raw data. The inferential statistics such as one-way ANOVA was used to test the difference in the means obtained as a function of different treatments. Moreover, the association between different categorical variables was assessed using Chi-Square test. The significance level was chosen to be 0.05 (or equivalently, 5%) by keeping in view the consequences of such an error. That is, we want to make the significance level as small as possible in order to protect the null hypothesis and to prevent, as far as possible, from inadvertently arriving at false conclusions.

Result & Discussion

Table 1: Impact of the elevated CO_2 concentrations. on the weight of cotton fruits

Cotton	CO_2 (ppm)	N	Mean (gm)	SD	SE	Min.	Max.	F	Sig.
Weight of fruit	Ambient OTC	10	4.6	±0.5	0.2	4.2	5.1	.249	.783
	Ambient Field	10	4.4	±0.4	0.1	3.9	4.9		
	450	10	4.0	±0.7	0.3	2.8	4.5		
	500	10	3.7	±0.9	0.4	2.5	4.5		
	550	10	3.2	±0.2	0.1	3.5	4.0		

SD: Standard Deviation; SE: Standard Error; Min.: Minimum; Max.: Maximum

The average weight of fruits on the cotton crop plant in the study area was presented in Table 1. The average impact of the elevated CO_2 concentration on the number of fruits on the cotton plant under the ambient OTC is 4.6±0.5and ambient field is 4.4±0.4. However, the weight of fruit on the cotton plants exposed to elevated CO_2 i.e. 450ppm was observed to be 4.0±0.7, for 500 ppm it was 3.7±0.9 and for 550ppm it was 3.2±0.2. Although there appears to be a decreasing trend in the weight of the fruit, the difference was statistically not significant. Thus, on the basis of the study results, it is concluded that there is noticeable change in the weight of fruits of cotton crop when exposed to higher CO_2 levels (Fig. 1).

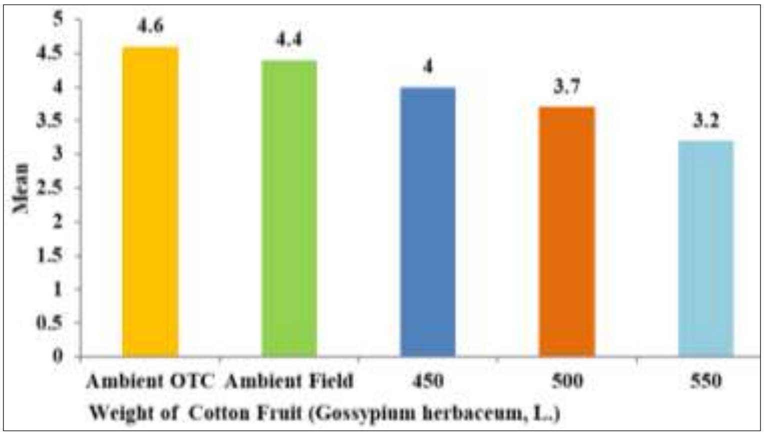

Fig 1: Average weight of fruits on the cotton crop plant exposed to elevated CO_2 concentrations.

Weight of Tur Pod (*Cajanus cajan*, L.)

Table 2: Information about the weight of Tur 100 seeds in the study area.

Tur	CO_2 (ppm)	N	Mean	SD	SE	Min.	Max.	F	Sig.
Weight of 100 seeds	Ambient OTC	10	3.5	±1.3	0.5	3.2	3.9	2.412	<0.05
	Ambient Field	10	3.1	±1.1	0.4	2.7	3.5		
	450	10	2.8	±0.4	0.06	2.4	3.1		
	500	10	2.6	±0.2	0.04	2.6	3.4		
	550	10	2.1	±0.3	0.02	3.3	3.9		

Above Table 2 presents results regarding the average weight of 100 seeds of Tur. The average weight of Tur seeds (100 seeds) obtained under the ambient OTC is 3.5±1.3 and ambient field is 3.1±1.1. The weight of Tur seeds observed when the cultivation was done at CO_2 levels 450, 500 and 550 ppm was 2.8±0.4, 2.6±0.2 and 2.8±0.3 respectively. The results indicated that there is a significant difference (<0.05) in the seed weight observed as a function of varying CO_2 concentration Thus, on the basis of the study results, it is concluded that there is noticeable change in the weight of Tur seeds with respect to CO_2 conc (Fig. 2).

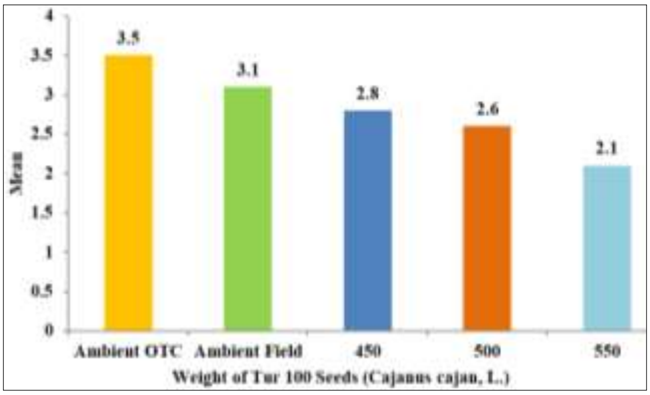

Fig 2: The average weight of Tur 100 seeds in the study area

Conclusion

Thus, on the basis of the study results, it is concluded that there is noticeable change in the number of fruits on Cotton, and Tur crops in the study area.

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