INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY

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EFFECT OF DIFFERENT CO_2 CONCENTRATIONS ON HEALTH OF COTTON & TUR

P A Lambat[1], A P Lambat[2] V S Dongre[2] and K J Cherian[3]
[1] Shri Mathuradas Mohota College of Science, Nagpur, M.S., India.
[2] Sevadal Mahila Mahavidyalaya & Research Academy, Nagpur, M.S., India.
[3] D R B Sindhu Mahavidyalaya, Nagpur, M.S., India.
Corresponding Author lambatashish@gmail.com

ABSTRACT:
The plant responses on elevated level of CO_2 by conducting experiments with different types of structure and simulation modeling which include growth chamber, controlled environmental chambers, open top chamber and free air CO_2 enrichment facilities, etc,. The effects of atmospheric CO_2 enrichment have been studied for three years in green house, controlled environmental chambers, OTCs and other elevated structures to confine the CO_2 gas around the experimental plants. Four units of OTCs were already established and plants have been exposed to controlled temp, humidity and various CO_2 for study of physiological changes in different growth: AMB: AMBIENT OUTSIDE, OTC1: AMBIENT $C0_2$ (CONTROL), OTC2: ELEVATED $C0_2$ (400ppm)+ Ambient Temp, OTC3: ELEVATED $C0_2$ (450ppm)+ Ambient Temp and OTC4: ELEVATED $C0_2$ 500ppm + Ambient Temp. Thus, on the basis of the study results, it is concluded that there is significant ($P<0.05$) difference in the rate of infection amongst different crops at an elevated CO_2 concentration from the ambient i.e. 550 ppm.
***Keywords**: Cotton, Tur, Elevated CO2, Ambient, ppm.*

INTRODUCTION:

The concentration of CO_2 in the atmosphere reached 379 ppm in 2005, which exceeds the natural range of values of the past 650,000 years (IPCC, 2007). An increase in CO_2 levels may encourage the production of plant biomass; however, productivity is regulated by water and nutrients availability, competition against weeds and damage by pests and diseases. Alternatively, a high concentration of carbohydrates in the host tissue promotes the development of biotrophic fungi such as rust (Chakraborty and Dutta*,* 2002). Thus, an increase in biomass can modify the microclimate and affect the risk of infection (Burdon, 1987; Agrios, 2005; Lambers *et. al.,* 2008). In general, increased plant density will tend to increase leaf surface wetness duration and regulate temperature and so make infection by foliar pathogens more likely (Huber and Gillespie, 1992; Dalla Marta *et. al.* 2005; Dalla Pria *et. al.,* 2006).

However, how abiotic stress factors interact to affect plants will be a key to understanding climate change effects on plants (Mittler, 2006; Valladares and Niinemets, 2008); By the contrast low concentration of carbohydrates, in the host tissue also promotes development of diseases, this because the susceptibly of plants increase by stress (caused by climate or fertilization). Experimental research on the effects of high atmospheric CO_2 concentrations on plant–pathogen interactions has received little attention and conflicting results have been published. Elevated levels of CO_2 can directly affect the growth of pathogens. For example, according to Chakraborty *and Dutta,* (2002), the growth of the germ tube, appressorium and conidium of *Colletotrichum gloeosporioides* fungi is slower at high concentrations of CO_2 (700 ppm). Germination rates of conidia on leaves were lower at CO_2 concentrations of 700 ppm than those observed at 350 ppm. However, once the pathogen infects the plant, the fungus quickly develops and achieves sporulation. In contrast, the rate of germination sporulation was greater at high concentrations of CO_2 (700 ppm).

Moreover, Mcelrone *et. al.* (2005) assessed how elevated CO_2 affects a foliar fungal pathogen, *Phyllosticta minima* of *Acer rubrum* growing in the understory at the Duke Forest free-air CO_2 enrichment experiment in Durham, North Carolina. *A. rubrum* saplings in the 6th, 7th and 8th years of the CO_2 exposure revealed that elevated CO_2 significantly reduced disease incidence, with 22, 27 and 8% fewer saplings and 14, 4 and 5% fewer leaves infected per plant in the three consecutive years, respectively. They concluded that the potential dual mechanism of reduced stomata opening and altered leaf chemistry that results in reduced disease incidence and severity under elevated CO_2 may be prevalent in many plant pathosystems where the pathogen targets the stomata.

MATERIALS & METHOD:

Cotton Crop (*Gossypium herbaceum L.*):

The cotton plant has perhaps the most complex structure of all major field crops. Its indeterminate growth habit and extreme sensitivity to adverse environmental conditions is unique. The growth of the cotton plant is very predictable under favorable moisture and temperature conditions. Growth follows a well-defined and consistent pattern expressed in days. Another useful and more precise way to assess crop development relies on using daily temperatures during the season to monitor progress. The heat unit concept utilizes accumulated hours above a critical temperature rather than calendar days in describing growth and development.

The developmental phases for cotton can be divided into five main growth stages: (1) germination and emergence 4 to 9 days (2) seedling establishment 27 to 38days (3) leaf area and canopy development (4) flowering and boll development 45 to 65days and (5) maturation 130 to 160days. The transitions between these stages are not always sharp and clear. Each stage may also have different physiological processes operating within specific requirements.

TUR Crop (*Cajanus cajan L.):*

Tur is grown as annual but other varieties grow like perennial plants. The plants are bushy, densely branched having a height of about 150 cm to 300 cm depending upon type and management practices. It bears tap root with well-developed lateral or secondary roots that consist nodules on them like any other leguminous plants. The stem is strong, woody, round but slightly ridged during active growth period having numerous branches. The leaves are pinnately compound and trifoliate with oblong, lanceolate leaflets. The flowers are arranged in recemose order. They open in the evening and remain open whole night and upto noon time of the next day. The structure of flower, nature of pollination, pod setting and pod characters are similar to that of any other papilionaceous plants.

The *Cajanus cajan* differs in plant character, pod character and maturity duration, etc. but most of the cultivated types belong to two categories.

1. ***Cajanus cajan var.bicolor*:** They are late maturing, plants grow very tall or probably they are tallest of both the types which are freely branched and bear flowers at the end of the branches. The pods are relatively longer and use to contain 4 to 5 seeds in them.
2. ***Cajanus cajan var.flavus***: They have shorter duration and accordingly they fall in early maturing category of plants. Plants are shorter, bushy having flowers at several points along the branches. The pods are also shorter which bear two to three seeds in them.

Tur needs moist and warm weather during germination (30-35^{0}C), slightly lower temperature during active vegetative growth (20-25^{0}C) but about 15-18^{0}C during flowering and pod setting, however, at maturity it needs higher temperature of around 35-40^{0}C. Water logging, heavy rains, frost are very harmful for the crop. Hailstorm or rain at maturity damages the entire crop.

The crop may be grown on any type of soil but sandy loam to clayey loam soils are supposed to be best. Soil must be very deep, well drained and free from soluble salts in them.

The developmental phases divided into five main growth stages: (1) germination and emergence (2) seedling establishment (3) leaf area and canopy development (4) flowering and boll development and (5) maturation.

Experimental Data

- Root length (cm)
- Shoot Length (cm)
- Number of leaves (Nos.)
- Number of Fruits (Nos.) Cotton, Tur, Moong, Groundnut, Soyabean
- Weight of Fruits (gm) Cotton, Groundnut, Soyabean.
- Weight of Seeds or 100 seed weight of Tur, Moong (gm).

The increasing CO_2 concentration of atmosphere and associated predictions of global warming have stimulated research programs to determine the likely effects of future elevated CO_2 levels on agricultural productivity and on the functioning of natural ecosystems.

The results on plant responses on elevated level of CO_2 by conducting experiments with different types of structure and simulation modeling which include growth chamber, controlled environmental chambers, open top chamber and free air CO_2 enrichment facilities, etc,. The effects of atmospheric CO_2 enrichment have been studied for three years in green house, controlled environmental chambers, OTCs and other elevated structures to confine the CO_2 gas around the experimental plants. The accuracy on maintenance of CO_2 inside chamber installed around the crops did not succeed in many other studies because of technical constrains. In the enclosed structure, the experiment will not be the same as that in the open top chamber. The OTCs were developed for the purpose where the basic metal frame fitted in the field would be covered with highly transparent material like polycarbonate sheet with 80 to 85% light transmission and is open at the top to avoid building up temperature and humidity. Four units of OTCs were already established and plants have been exposed to controlled temp, humidity and various CO_2 for study of physiological changes in different growth

AMB: AMBIENT OUTSIDE

OTC1: AMBIENT $C0_2$ (CONTROL)

OTC2: ELEVATED $C0_2$ (400ppm)+ Ambient Temp

OTC3: ELEVATED $C0_2$ (450ppm)+ Ambient Temp

OTC4: ELEVATED $C0_2$ 500ppm + Ambient Temp

RESULTS AND DISCUSSION:

The impact of elevated CO_2 concentration on the health of major crops of the study area is presented Table 1. The data was collected every 2 weeks but the final data presented is at onset of reproductive phase of the plant. The data indicated that for Cotton, 22 plants were infected at CO_2 concentration of 450 ppm; however, for the other Tur, crop, it was 64. Thus, it is evident that the prevalence as well as gravity of disease in different crops at CO_2 concentration of 450 ppm is dissimilar. More specifically, it was observed that highest impact (negative) was evident with the Tur crop. Thus, on the basis of the study results, it is concluded that there is significant ($P<0.05$) difference in the scale of infection amongst different crops at an elevated CO_2 concentration from the ambient i.e. 450 ppm which is shown in (Fig. 1).

Impact of elevated CO_2 concentration (500 ppm) on the incidence of infection to various crops as compared to Ambient Field and Ambient OTC condition.

The impact of elevated CO_2 concentration 500 ppm on the health of various crops prevailing in the study area is presented in Table 6.11 and Fig.1 The data indicated that for Cotton, 27 plants were infected at CO_2 concentration of 500 ppm, and Tur 69. Thus, it is evident that the prevalence as well as severity of disease in different crops at CO_2 concentration of 500 ppm is dissimilar. More specifically, it was observed that highest impact (negative) was evident with the Moong and Tur crops. Thus, on the basis of the study results, it is concluded that there is significant ($P<0.05$) difference in the rate of infection amongst different crops at an elevated CO_2 concentration from the ambient i.e. 500 ppm.

Impact of elevated CO_2 concentration (550 ppm) on the incidence of infection to various crops as compared to Ambient Field and Ambient OTC condition

The impact of elevated CO_2 concentration 550 ppm on the health of various crops prevailing in the study area is presented in Table1. The data indicated that for Cotton, 33 plants were infected at CO_2 concentration of 550 ppm and 73 for Tur. Thus, it is evident that the prevalence as well as gravity of disease in different crops at CO_2 concentration of 550 ppm is dissimilar. More specifically, it was observed that highest impact (negative) was evident with Tur crop. It is reported that plant pathogen (*Erysiphe cichoracearum*) aggressiveness is increased under CO_2, together with changes in the leaf epidermal characteristics of the model plant *Arabidopsis thaliana* L. Stomatal density, guard cell length and trichome numbers on leaves developing post-infection are increased under CO_2 in direct contrast to non-infected responses (Janice and Ruth, 2009). It was reported by previous researchers that the acclimatization CO_2 was correlated positively with leaf mass per area, dry matter content and carbon (C) content and negatively with nitrogen (N) content at both stages. Therefore, these leaf properties could not explain the changes in host-plant susceptibility between stages of fungal growth on the leaf surface (Kaori *et. al.,* 2015).

CONCLUSION:

Thus, on the basis of the study results, it is concluded that there is significant ($P<0.05$) difference in the rate of infection amongst different crops at an elevated CO_2 concentration from the ambient i.e. 550 ppm.

ACKNOWLEDGMENT:

Researchers are thankful to Dr. K D Thakur, HOD, Plant Pathology for his generous help to conduct experiment in OTC chamber and Field of Dr.P D K V's College of Agriculture.

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		Total			Chi-Square Test Results
		Cotton	Tur		
Ambient OTC	Infected (nos.)	17	35	140	x^2= 34.722 <0.05
	Healthy	83	65	360	
	Total	100	100	500	
Ambient Field	Infected (nos.)	14	32	128	x^2= 37.13 <0.05
	Healthy	86	68	372	
	Total	100	100	500	
At 450ppm	Infected	22	64	229	x^2= 69.805 <0.05
	Healthy	78	36	271	
	Total	100	100	500	
At 500ppm	Infected	27	69	248	x^2=65.732 P<0.05
	Healthy	73	31	252	
	Total	100	100	500	
At 550ppm	Infected (nos.)	33	73	268	x^2=64.301 P<0.05
	Healthy	67	27	232	
	Total	100	100	500	