Response of Cotton and Tur Crops at Elevated CO_2 Conditions in OTC

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Abstract:
Climate is an important factor of agricultural productivity. The fundamental role of agriculture in human welfare concern has been expressed by many organizations and others regarding the potential effects of climate change on agricultural productivity. In the year 2011, 2012 and 2013 the seeds were sown in the first week of July depending on the rainfall and climatic conditions. Simultaneously the seed were also sown in controlled Open Top CO_2 Chambers at Plant Pathology Department of Dr. P D K V'S College of Agriculture, Nagpur. Although there was no significant difference in the root length (cm) in the Cotton but there was significant and noticeable change in the root length (cm) of Tur crop in the study area. Although there was no significant difference in the shoot length (cm) in the Tur but there was significant and noticeable change in the shoot length (cm) of Cotton. Although was significant and noticeable change in the number of leaves of Cotton, Tur crops in the study area.
Keywords: Climate Change, Elevated CO_2, Shoot length, Root Length, Decades.

Introduction:

The strong trends in climate change already evident, the likelihood of further changes occurring and the increasing scale of potential climate impacts give urgency to addressing agricultural adaptation more coherently. There are many potential adaptation options available for marginal change of existing agricultural systems, often variations of existing climate risk management. We show that implementation of these options is likely to have substantial benefits under moderate climate change for some cropping systems. However, there are limits to their effectiveness under more severe climate changes. Hence, more systemic changes in resource allocation need to be considered, such as targeted diversification of production systems and livelihoods. We argue that achieving increased adaptation action will necessitate integration of climate change-related issues with other risk factors, such as climate variability and market risk and with other policy domains, such as sustainable development.
Climate is an important factor of agricultural productivity. The fundamental role of agriculture in human welfare concern has been expressed by many organizations and others regarding the potential effects of climate change on agricultural productivity. Interest of this matter has motivated a substantial body of research on climate change and agriculture over the past decade.

Climate change is expected to agricultural and livestock production, hydrologic balances, input supplies and other components of agricultural systems.

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.

Using mathematical models, Carter *et al.* (1996[1]) 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[2]) 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. In coral honey suckle; total biomass was only 40% greater in the elevated CO_2 treatments. Branching was quadrupled but had not proceeded long enough to affect total leaf area. Main stem height was increased 36% at 1,000 µl/liter CO_2. In the same light the study was designed to study effect of elevated CO_2 conditions at 450ppm, 500ppm and 550ppm on vegetative growth of Cotton (*Gossipiyum herbaceum, L*), Tur (*Cajanus cajan,* L).

Material Methods:

In the year 2011, 2012 and 2013 the seeds were sown in the first week of July depending on the rainfall and climatic conditions. Simultaneously the seed were also sown in controlled Open Top CO_2 Chambers at Plant Pathology Department of Dr. P D K V'S College of Agriculture, Nagpur. In each plot seeds were sown in 10 rows of ten seeds each. The seeds were sown at a distance of 10-15cm from each other. In one plot only one type of seeds were sown. The plants were also grown in elevated conditions like increased CO_2 or increase in temperature or both in Open Top CO_2 Chambers (OTC). The seeds which were sown were the cash crops of Vidarbha region which was decided by conducting the survey of previous data bases of Nagpur districts of Agriculture Statistical Department at and which crops are highly affected by the diseases in Vidarbha district. So the crops which were selected were Cotton (*Gossipiyum herbaceum, L*), Tur (*Cajanus cajan,* L).

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1 Carter, T.R.; Saarikko, R.A. and Niemi, K.J. (1996), Assessing the risks and uncertainties of regional crop potential under a changing climate in Finland. Agricultural and Food Science in Finland, 5, 329-350.

2 Thomas R.B. and Strain B.R. (1991), Root restriction as a factor in photosynthetic acclimation of cotton seedlings grown in elevated CO2. Plant Physiol 96:627–634

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 analyzer ,PC linked supervisory control and data acquisition (SCADA). Four units of Open Top Chambers for elevated CO_2 study were provided by department with high quality multilayered polycarbonate sheets (4mm thickness) of 3X3X4mt. dimensions with GI/MS structure with proper foundation and grouting. A suitable door of 6X3 ft size is provided in each chamber. Multilayered clear polycarbonate sheet with 80-85% light transmission level is used for Open Top Chamber structure.

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. Three 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.

Result And Discussion:

The average root length (cm) of the crops in the study area is presentated in Table 1.1. The average root length of cotton plant under the ambient OTC is 7.5 ±0.3and the average root length of cotton plant under the ambient field is 7.3. ±0.4. The root length (cm) in the cotton crop of the study area with 450 ppm 8.5±0.4, 500 ppm 8.8±0.2 and 550 ppm 8.9±0.2 No significant difference was found. The average root length of Tur plant under the ambient OTC is 7.6 ±0.4and ambient field is 7.5 ± 0.3 respectively. The root length (cm)in the Tur crop of the study area with 450ppm 8.6±0.7, 500 ppm 9.4±0.6 and 550 ppm 10.5±0.9 Significant difference was found ($P<0.05$).

Above Table 1.2 presents results of the average shoot length (cm) of the crops in the study area. The average shoot length of cotton plant under the ambient OTC is 58.4 ±10.1and ambient field is 56.1±9.8 respectively. The shoot length (cm) in the cotton crop of the study area with 450 ppm 61.1±12.6, 500 ppm 64.9±14 and 550 ppm 73.9±10.8. Significant difference was found ($P<0.05$). The average shoot length of Tur plant under the ambient OTC is 94.5 ±12.8 and ambient field is 93.1±12.3. The shoot length (cm) in the Tur crop of the study area with 450ppm 99.2±16.2, 500 ppm 99.3±18.1 and 550 ppm 109±15.7. No Significant difference was found.

The average number of leaves in the crop plant in the study area. The average number of leaves of Cotton plant under the ambient is presented in Table 1.3. It shows that OTC is 38.5 ±7.1 and ambient field is 36.3±6.4 respectively. The number of leaves in the cotton crop of the study area with

450ppm 40.8±8.5, 500ppm 49.3±18.5 and 550ppm 62.8±17.0. Significant difference was found ($P<0.05$). The average number of leaves of Tur plant under the ambient OTC is 110.4±11.7 and ambient field is 108.5±10.9. The number of leaves in the Tur crop of the study area with 450 ppm 116.0±13.9, 500ppm 122.0±19.9 and 550ppm 132.5±17. Significant difference was found ($P<0.05$).

Although there was no significant difference in the root length (cm) in the Cotton but there was significant and noticeable change in the root length (cm) of Tur crop in the study area. Although there was no significant difference in the shoot length (cm) in the Tur but there was significant and noticeable change in the shoot length (cm) of Cotton. Although was significant and noticeable change in the number of leaves of Cotton, Tur crops in the study area.

Conclusion:

Previous researchers have reported that vegetative growth was always increased by elevated CO_2 Allen *et al.* (1987) summarized the photosynthetic, biomass and seed yield responses of several experiments which was replicated in present study that there is noticeable change in the root length (cm) of Tur crop in the study area, it is also concluded that there is noticeable change in the shoot length (cm) of Cotton crop and that there is noticeable change in the number of leaves of Cotton and Tur crops in the study area.

Table 1.1 : Root Length

	CO_2 ppm	**N**	**Mean**	**SD**	**SE**	**Min.**	**Max.**	**F**	**Sig.**
Cotton	Ambient OTC	5	7.5	±0.3	0.1	7.1	7.8	1.898	**<0.05**
	Ambient Field	5	7.3	±0.4	0.1	6.8	7.7		
	450	5	8.5	±0.4	0.2	8	9		
	500	6	8.8	±0.2	0.1	8.5	9.1		
	550	4	8.9	±0.2	0.1	8.7	9.1		
Tur	Ambient OTC	5	7.6	±0.4	0.2	6.9	7.9	8.241	**<0.05**
	Ambient Field	5	7.5	±0.3	0.1	7.1	7.9		
	450	5	8.6	±0.7	0.3	7.8	9.5		
	500	6	9.9	±0.6	0.2	9.4	11		
	550	4	10.5	±0.9	0.4	9.9	11.8		

Table 1.2 : Shoot Length

	CO_2 ppm)	N	Mean cms	SD	SE	Min.	Max.	F	Sig.
Cotton	Ambient OTC	5	58.4	±10.1	3.2	56	60	1.143	<0.05
	Ambient Field	5	56.1	±9.8	2.8	54	57		
	450	5	61.1	±12.6	5.6	46	78		
	500	6	64.9	±14.0	5.7	50	85		
	550	4	73.9	±10.8	5.4	61	86		
Tur	Ambient OTC	5	94.5	±12.8	4.2	92	98	0.487	NS
	Ambient Field	5	93.1	±12.3	5.3	89	97		
	450	5	99.2	±16.2	7.2	80	120		
	500	6	99.3	±18.1	7.4	82	124		
	550	4	109	±15.7	7.9	91	125		

Table 1.3 : No. of Leaves

	CO_2 (ppm)	N	Mean	SD	SE	Min.	Max.	F	Sig.
Cotton	Ambient OTC	5	38.5	±7.1	2.1	35	40	2.25	<0.05
	Ambient Field	5	36.3	±6.4	1.9	34	39		
	450	5	40.8	±8.5	3.8	28	50		
	500	6	49.3	±18.5	7.6	30	77		
	550	4	62.8	±17.0	8.5	44	84		
Tur	Ambient OTC	5	110.4	±11.7	4.3	108	114	1.01	<0.05
	Ambient Field	5	108.5	±10.9	3.9	106	110		
	450	5	116	±13.9	6.2	98	136		
	500	6	122	±19.9	8.1	102	148		
	550	4	132.5	±17.1	8.6	109	149		

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