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Effect of Climate Change on Yield of Groundnut (*Arachishy pogaea* L.)

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ABSTRACT

The present investigation on climate change and its impact on growth of groundnut crop was conducted during kharifseason of 2015-16 using Open Top Chamber (OTC's) at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka. Four circular OTC's at MARS, Raichur were used for the present investigations.groundnut was raised in different OTC's having standard climate change treatment (IPCC, 2013). Elevated CO_2 and temperature significantly influenced the yield of groundnut. climate change treatments have influenced greatly the growth hence it had greater impact on yield parameters also. Number of pods recorded in eCO_2 (550 ppm) was significantly higher in both theeCO_2 levels with or without temperature wherein, eCO_2 (550 ppm) recorded 25.06 pods per plant. Whereas, the reference plot recorded significantly minimum number of pods (15.84 pods/plant). Likewise, pod yield recorded was significantly higher in both the eCO_2 levels wherein, eCO_2 (550 ppm) recorded (24.29 g/ plant with 37.38 % increase in pod yield). Whereas, the aCO_2 treatments recorded minimum pod yield wherein, the reference OTC (390 ppm) registered (16.59/plant with 8.3% increase in yield). Though the pod yields were more in elevated CO_2 treatments but the oil percentage was very less. Higher oil content (45.34%) was recorded in reference plot.
Key words: *OTC's, LAI, Climate change*

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INTRODUCTION

Climate which is the mean of variability of key weather parameters is a primary determination of agricultural productivity. Persistent and significant change in the average pattern of weather in a place for an extended period is known as climate change (Anon., 2014a). Given the role of agriculture in human welfare, concerns are raised regarding the potential effects of climate change on agricultural productivity. Climate change is closely linked with atmospheric concentration of CO2, methane, nitrous oxide and other green house gases which are known to trap the heat from solar radiations. As the concentrations of green house gases increase, the overall temperature also increase resulting in differential precipitation leading to abrupt variation in crop productivity and herbivore action in agriculture (Anon., 2014a).

It is well established that the global atmospheric CO_2 level is increasing due to eater process (Berner, 1992) and biological activity (Watson *et al*., 1991). It has been reported by federal agencies that CO_2 has been increased approximately 30 per cent since the industrial revolution which is believed to be responsible for an increase of about 0.66 °C in mean annual global surface temperature. Further, the temperature is anticipated to increase 1.4 to 5.8 °C by 2100 with equally increasing atmospheric CO_2, which is considered to be chiefly responsible for the greenhouse effect, which has increased from approximately 310 ppm in 1950 to about 400 ppm in the year 2011. This concentration is estimated to reach levels of 421 to 936 ppm by the end of the 21st century, according to forecasting models, depending on the magnitude of future human activities (IPCC, 2013).

These changes in climatic factors (CO_2, temperature, vapor pressure deficit and rainfall) will alter plant growth and development processes and most likely have negative impact on crop productivity, especially in the semi-arid tropical regions, where the current temperatures are already high and close to the upper limits beyond which the plant processes will be adversely affected. Therefore, in spite of some expected benefits of increased CO_2 concentration on some crops, global warming poses a potential threat to agricultural production and productivity throughout the world. Increased incidence of weeds, pests and plant diseases with climate change may cause even greater economic losses to agricultural production. It is projected that even small rise in temperature (1-2 ºC) at lower latitudes, especially in the seasonally dry tropical regions (IPCC, 2007) would decrease crop productivity.

In general C3 plants are more responsive to elevated CO2, which lead to greater main shoot length, elongation of branches, individual leaf area per plant and dry mass. It is understood that accumulation of sugars and starch in the leaves of elevated CO2 grown plants reflect higher photosynthetic carbon assimilation (Cure and Acock, 1986). So, to study the implications of climate change in terms of eCO2 and temperature, groundnut was chosen for study. Groundnut (*Arachishypogaea* L.) is C_3 plant and is popularly known as "King of oilseed crops" and considered as an important source of edible oil and third most important source of vegetable protein. It contains about 50 per cent oil, 25-30 per cent protein, 20 per cent carbohydrate and five per cent fibre and ash which make a substantial contribution to human nutrition and also a valuable source of vegetable protein. It contains about 50 per cent oil, 25-30 per cent protein, 20 per cent carbohydrate and five per cent fibre and ash which make a substantial contribution to human nutrition and also a valuable source of vitamins namely, E, K and B, high energy value, protein content and minerals. It is grown over an area of 26.62 million ha spread over 84 countries with an annual production of 35.66 million tonnes of pods with a productivity of 1348 kg ha-1 (Anon., 2013). China, India, Nigeria, the United States of America and Myanmar are the major groundnut growing countries. India is the second largest producer of groundnut in the world, with an average annual production of 5.51 million tonnes(Anon., 2013). In India groundnut is being grown over an area of 5.52 million hectares with a total production of 9.62 mt with productivity of 1750 kg ha-1 (Anon., 2015). Six major groundnut growing states *viz*., Gujarat, Andhra Pradesh, Tamil Nadu, Rajasthan, Karnataka and Maharashtra, contribute 90 per cent of total groundnut production. Karnataka ranks fifth in the country with a production of 0.65 million tonnes from an area of 0.73 million hectares and an average yield of 907 kg ha^{-1} (Anon., 2015).

Profound impacts of elevated CO_2 on terrestrial ecosystem, especially on chemical composition and nutrient quality of plants, are expected, that is significant increase in photosynthesis, growth, water use efficiency, leaf area, yield and decrease in foliar nitrogen of plants, particularly C_3 plants (Bazzaz, 1990). This paper attempts to review the current state of knowledge of climate factor effects on yield and oil content of groundnut.

MATERIAL AND METHODS

The present investigation on effect of climate change on growth and yield of groundnut was conducted during *kharif*season of 2015-16 using Open Top Chamber (OTC's) at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Raichur, Karnataka. Raichur is situated in the North Eastern Dry Zone (Zone-II) of Karnataka between 16°15' N latitude and 77° 20' E longitudes with an altitude of 389 m above the mean sea level.

The eCO_2 and temperature (abiotic factors) were considered as the main treatments in the present investigations. Each OTC was considered as a treatment for this study and the set of treatments designed as the recommendations of IPCC, (2013) are as follows.

T_1: Ambient CO_2 of 390 ± 25 ppm with 2 °C rise in temperature.

T_2: Elevated CO_2 of 550 ± 25 ppm.

T_3: Elevated CO_2 of 550 ± 25 ppm with 2 °C rise in normal temperature.

T_4: Reference OTC

T_5: Reference plot. (As saturated check)

Establishment of crop in OTC's

Popular groundnut variety TMV-2 was raised in eight cement pots size of 1×1 ft which was filled with red soil, FYM (7.5 tonnes/ha) and chemical fertilizers were added to each pot (25:75:25 kg/h through straight fertilizers) and vermicompost (1 ton/ha) as per recommendations of University of Agricultural Sciences, Raichur. Each treatment has eight pots and each pot consisting of two groundnut plants were treated as replicates in different OTC's having standard climate change treatment (IPCC, 2013). Pots were irrigated regularly and observations were taken (Anon., 2014b).

Effect of elevated CO_2 and temperature on growth of groundnut

Yield parameters like number of pods per plant, pod yield and oil content of groundnut recorded.

Statistical analysis

The effects of CO_2 treatment on yield and oil content were analyzed using one way ANOVA. Treatment means were compared and separated using least significant difference (LSD) at $p < 0.01$.

RESULTS

Since the climate change treatments have influenced greatly the growth hence it had greater impact on yield parameters also. Number of pods recorded in eCO_2 (550 ppm) was significantly higher in both theeCO_2 levels with or without temperature wherein, eCO_2 (550 ppm) recorded 25.06 pods per plant which was on par with eCO_2 +eTemperature (550 ppm + 2 °C) treatment (22.63 pods/plant). Whereas, the reference plot recorded significantly minimum number of pods (15.84 pods/plant) which was on par with reference OTC (390 ppm) treatment (17.08 pods/plant) and aCO_2 + eTemperature (390 ppm + 2 °C) treatment (18.66 pods/ plant). Likewise, pod yield recorded was significantly higher in both the eCO_2 levels wherein, eCO_2 (550 ppm) recorded (24.29 g/ plant with 37.38 % increase in pod yield) which was on par with the eCO_2 +eTemperature (550 ppm + 2 °C) treatment (21.88 g/plant with 30.48% increase in yield). Whereas, the aCO_2 treatments recorded minimum pod yield wherein, the reference OTC (390 ppm) registered (16.59/plant with 8.3% increase in yield) which was non-significant with the rest of the aCO_2 treatment.

Though the pod yields were more in elevated CO_2 treatments but the oil percentage was very less. Higher oil content (45.34%) was recorded in reference plot which was on par with reference OTC (45.23 % with 0.24% decrease in oil content) and eCO_2 +eTemperature (550 ppm + 2 °C) treatment (45.30% with 0.08% decrease in oil content). Significantly least oil content was recorded in eCO_2 (550 ppm) treatment (44.11 % with 2.71% decrease in oil content) which was on par with aCO_2 + eTemperature (390 ppm + 2 °C) treatment (44.33% with 2.22% decrease in oil content) (Table1).

Table 1. Effect of eCO_2 and temperature on groundnut yield and oil content

Treatment	Yield parameters										% decrease in oil content
	Number of pods/plant			Pod yield/plant(gm)			Oil content (%)				
	August sown	September sown	Mean	August sown	September sown	Mean	% increase in pod yield	August sown	September sown	Mean	
eCO_2 (550ppm)	25.75	24.38	25.06	25.21	23.38	24.29	37.38	44.85	43.36	44.11	-2.71
eCO_2+eTemp. 550ppm+2 °C)	22.39	22.88	22.63	21.48	22.28	21.88	30.48	45.90	44.70	45.30	-0.08
aCO_2+eTemp. (390ppm+2 °C)	19.13	18.19	18.66	18.44	17.70	18.07	15.58	44.98	43.68	44.33	-2.22
Reference OTC	17.66	16.50	17.08	17.31	15.86	16.59	8.31	45.85	44.61	45.23	-0.24
Reference plot	16.56	15.13	15.84	15.79	14.63	15.21	-	45.93	44.76	45.34	-
CV (%)	**8.73**	**9.48**	**9.11**	**9.90**	**9.78**	**9.84**	**-**	**0.44**	**1.27**	**0.86**	**-**
S.Em±	**0.89**	**0.92**	**0.90**	**0.97**	**0.92**	**0.95**	**-**	**0.10**	**0.28**	**0.19**	**-**
CD(P=0.01)	**3.83**	**3.98**	**3.90**	**4.20**	**3.96**	**4.08**	**-**	**0.43**	**1.22**	**0.82**	**-**

DISCUSSION

Number of pods recorded in eCO_2 (550 ppm) was significantly higher in both theeCO_2 levels wherein, eCO_2 (550 ppm) recorded 25.06 pods per plant which was on par with eCO_2 +eTemperature (550 ppm + 2 °C) treatment (22.63 pods/plant). Whereas, the reference plot recorded minimum number of pods (15.84 pods/plant) which was on par with reference OTC (390 ppm) treatment (17.31pods/plant) and aCO_2 + eTemperature (390 ppm + 2 °C) treatment (18.44 pods/ plant). Likewise, pod yield recorded was significantly higher in both the eCO_2 levels wherein, eCO_2 (550 ppm) recorded 24.29 g per plant with 37.38 per cent increase in yield over reference plot. This treatment was on par with the eCO_2 +eTemperature (550 ppm + 2 °C) treatment (21.88 g/plant with 30.48 % increase in yield). Whereas, the aCO_2 treatments recorded minimum pod yield wherein, the reference plot (390 ppm) registered 16.59 g per plant. Though the pod yields were more in elevated CO_2 treatments but the oil percentage was very less. Higher oil content (45.34 %) was recorded in reference plot followed by (45.30% with 0.08% decrease in oil content) recorded in eCO_2 +eTemperature (550 ppm + 2 °C) least oil content recorded under eCO_2 (550 ppm) treatment (44.11% with 2.71% decrease in oil content) (Fig.1).

Results of present investigations showed significant increase in the yield parameters and oil content in eCO_2 conditions compared to aCO_2 conditions. Various studies in line with the present findings with respect to yield parameter and oil content wherein, groundnut grown under eCO_2 treatments recorded maximum pod number, pod weight, kernel weight, seed number and oil content (Yadav*et al*., 2011). Similarly, in some other crops like soya (Dongaxiao*et al*., 2013), castor (Vanaja*et al*., 2008), lucerne (James *et al*., 2014) maximum yield recorded under eCO_2 and temperature.

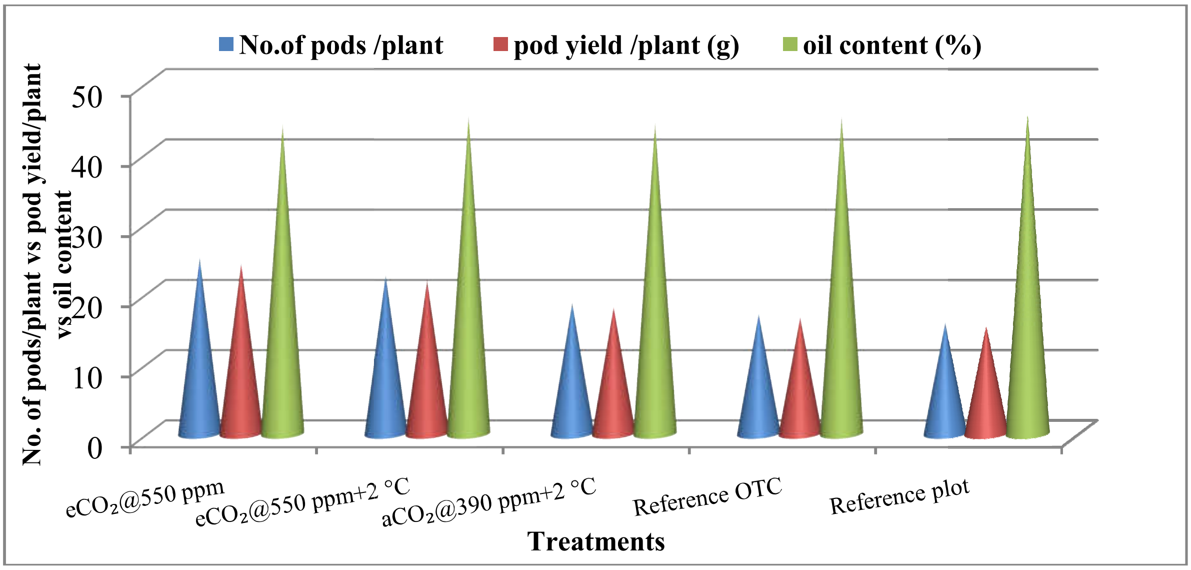

Fig.1.Effect of eCO_2 and temperature on yield parameters and oil content of groundnut

CONCLUSIONS

Increased yield in eCO_2 treatment where, maximum pod yield of 24.29 g per plant was obtained which was 37.38 per cent more compared to reference plot. On the contrary, 2.71 per cent oil content decreased in eCO_2 treatment compared to reference plot.

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