**Effect of Climate Change on Yield of Groundnut (Arachis hypogaea L.)**

Shwetha¹, Sreenivasa A. G¹, Ashoka J¹, Sushila Nadagoud¹ and P. H. Kuchnoor²

1. Department of Agricultural Entomology, University of Agricultural Sciences, Raichur
2. Department of Genetics and Plant Breeding, University of Agricultural Sciences, Raichur

E-mail: shwethahatti1200@gmail.com

**ABSTRACT**

The present investigation on climate change and its impact on growth of groundnut crop 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. 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 CO₂ and temperature significantly influenced the yield of groundnut. Climate change treatments have influenced the growth hence it had greater impact on yield parameters also. Number of pods recorded in eCO₂ (550 ppm) was significantly higher in both the eCO₂ levels with or without temperature wherein, eCO₂ (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 eCO₂ levels wherein, eCO₂ (550 ppm) recorded (24.29 g/plant with 37.38 % increase in pod yield). Whereas, the eCO₂ 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 CO₂ 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

Received 12.07.2017  
Revised 09.08.2017  
Accepted 24.08.2017

**INTRODUCTION**

Climate which is the mean of variability of key weather parameters is a primary determinant 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 greenhouse gases which are known to trap the heat from solar radiations. As the concentrations of greenhouse 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 CO₂ level is increasing due to eater process (Berner, 1992) and biological activity (Watson et al., 1991). It has been reported by federal agencies that CO₂ 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 CO₂, 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 (CO₂ 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 CO₂ 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 °C) 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 Acoc, 1986). So, to study the implications of climate change in terms of eCO2 and temperature, groundnut was chosen for study. Groundnut (Arachis hypogaea L.) is C3 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 CO2 on terrestrial ecosystem, especially on chemical composition and nutrient quality of plants, is expected, that is significant increase in photosynthesis, growth, water use efficiency, leaf area, yield and decrease in foliar nitrogen of plants, particularly C3 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 eCO2 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.

T1: Ambient CO2 of 390 ± 25 ppm with 2 °C rise in temperature.
T2: Elevated CO2 of 550 ± 25 ppm.
T3: Elevated CO2 of 550 ± 25 ppm with 2 °C rise in normal temperature.
T4: Reference OTC
T5: Reference plot. (As saturated check)

Establishment of crop in OTCs

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 CO2 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 CO2 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 eCO₂ (550 ppm) was significantly higher in both the eCO₂ levels with or without temperature wherein, eCO₂ (550 ppm) recorded 25.06 pods per plant which was on par with eCO₂+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 aCO₂+eTemperature (390 ppm + 2 °C) treatment (18.66 pods/plant). Likewise, pod yield recorded was significantly higher in both the eCO₂ levels wherein, eCO₂ (550 ppm) recorded (24.29 g/plant with 37.38 % increase in pod yield) which was on par with the eCO₂+eTemperature (550 ppm + 2 °C) treatment (21.88 g/plant with 30.48% increase in yield). Whereas, the aCO₂ 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 aCO₂ treatment.

Though the pod yields were more in elevated CO₂ 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 eCO₂ + eTemperature (550 ppm + 2 °C) treatment (45.30% with 0.08% decrease in oil content). Significantly least oil content was recorded in eCO₂ (550 ppm) treatment (44.11 % with 2.71% decrease in oil content) which was on par with aCO₂ + eTemperature (390 ppm + 2 °C) treatment (44.33% with 2.22% decrease in oil content) (Table 1).

**DISCUSSION**

Number of pods recorded in eCO₂ (550 ppm) was significantly higher in both the eCO₂ levels wherein, eCO₂ (550 ppm) recorded 25.06 pods per plant which was on par with eCO₂ + 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 (17.31 pods/plant) and aCO₂ + eTemperature (390 ppm + 2 °C) treatment (18.44 pods/plant). Likewise, pod yield recorded was significantly higher in both the eCO₂ levels wherein, eCO₂ (550 ppm) recorded (24.29 g/plant with 37.38 % increase in pod yield) which was on par with the eCO₂ + eTemperature (550 ppm + 2 °C) treatment (21.88 g/plant with 30.48% increase in yield). Whereas, the aCO₂ 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 aCO₂ treatment.

Results of present investigations showed significant increase in the yield parameters and oil content in eCO₂ conditions compared to aCO₂ conditions. Various studies in line with the present findings with respect to yield parameter and oil content wherein, groundnut grown under eCO₂ 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 (Dongxiaioa et al., 2013), castor (Vanaja et al., 2008), lucerne (James et al., 2014) maximum yield recorded under eCO₂ and temperature.

**Table 1. Effect of eCO₂ and temperature on groundnut yield and oil content**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of pods/plant</th>
<th>Pod yield/plant(gm)</th>
<th>Oil content (%)</th>
<th>% decrease in oil content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>August sown</td>
<td>September sown</td>
<td>Mean</td>
<td>August sown</td>
</tr>
<tr>
<td>eCO₂ (550ppm)</td>
<td>25.75</td>
<td>24.38</td>
<td>25.06</td>
<td>25.21</td>
</tr>
<tr>
<td>eCO₂+Temp. (550ppm+2 °C)</td>
<td>22.39</td>
<td>22.88</td>
<td>22.63</td>
<td>21.48</td>
</tr>
<tr>
<td>aCO₂+Temp. (390ppm+2 °C)</td>
<td>19.13</td>
<td>18.19</td>
<td>18.66</td>
<td>18.44</td>
</tr>
<tr>
<td>Reference OTC</td>
<td>17.66</td>
<td>16.50</td>
<td>17.08</td>
<td>17.31</td>
</tr>
<tr>
<td>Reference plot</td>
<td>16.56</td>
<td>15.13</td>
<td>15.84</td>
<td>15.79</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.73</td>
<td>9.48</td>
<td>9.11</td>
<td>9.90</td>
</tr>
<tr>
<td>S.Em±</td>
<td>0.89</td>
<td>0.92</td>
<td>0.90</td>
<td>0.97</td>
</tr>
<tr>
<td>CD(P=0.01)</td>
<td>3.83</td>
<td>3.98</td>
<td>3.90</td>
<td>4.20</td>
</tr>
</tbody>
</table>

This table shows the effect of eCO₂ and temperature on groundnut yield and oil content. The results indicate that eCO₂ treatments (550 ppm) significantly increased the number of pods and pod yield compared to aCO₂ treatments (390 ppm). The oil content was also significantly higher in eCO₂ treatments compared to aCO₂ treatments.
CONCLUSIONS
Increased yield in eCO₂ 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 eCO₂ treatment compared to reference plot.

REFERENCES

CITATION OF THIS ARTICLE