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**EXTENDED ABSTRACT**

# Effects of Elevated Carbon Dioxide and Deficit Irrigation Regimes on Morphological and Physiological Characteristics of Lentil (Variety Kimia)

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## Introduction

Studies have shown that the global climate has been dramatically changed during last decades. The results of the investigations have shown that enhancement of greenhouse gases due to human activities is one of the main factors of climate change in the present century. $CO_2$ is one of the most important greenhouse gases, which has begun to increase rapidly since the mid-19$^{th}$ century. Studies have shown that carbon dioxide concentrations have risen by about 43% from 277-280 ppm since the late 1700s and now the concentration of this gas is close to 400 ppm (Samenow, 2013). According to scientists, carbon dioxide is responsible for 61% of the total global warming.

In addition to the harmful effects of increasing the carbon dioxide concentration and global warming, this gas has a positive effect on agriculture, which increases its importance. The results of the research indicate that increasing $CO_2$ concentration causes photosynthesis enhancement also by increasing the photosynthesis dry matter weight increase, and consequently the amount of production increases (Semenow et al., 2012).

Rogers et al., (1994), indicated that doubling carbon dioxide concentration has led to an increase in plants' yield approximately by 33%. In addition, environmental conditions such as light, temperature, water and available nutrients, moisture, etc., and the interaction between them, overwhelms the effect of plants on changes in carbon dioxide concentration.

## Material and Methods

In order to investigate the effect of $CO_2$ concentration, an experiment was carried out in three large-scale climate chambers at Research Greenhouse of the Agricultural collage of Ferdowsi University of Mashhad, Iran, during 2014-2015. In this research, the effects of increasing CO2 concentration from 400 to 800 and 1200 ppm were studied on growth and yield of lentils (*Lens culinaris*, Kimia) at four irrigation levels (%125Water Requirement, WR,%75WR and %5WR). Experimental design was factorial experiment in a complete randomized block design with four replications.

In order to maintain the homogeneity of environmental conditions, such as temperature, humidity levels and CO2 concentration, pods were located in three transparent isolated chambers

with dimensions of 3 m (length) × 1.5 m (width) × 2 m (height). With the intention of inject the correct amount of $CO_2$, a photocell was used, which was automatically turned on/off at day and night.

Irrigation treatments were fractions of full water requirements (WR). At each irrigation interval, the pots were weighed; then sufficient water was added until the pods' weight reached the calculated weight. The difference between two consecutive weights was an indication of the evapotranspiration during that interval.

**Results and Discussion**

The results of this study indicate that reducing irrigated water causes a significant reduction in stem height. Also it has been shown that by increasing carbon dioxide concentration, stem height increases significantly. Moreover, shoot and root dry weight increase by the enhancement of CO2. Results showed that the enhancement of shoot dry weight due to the increasing of carbon dioxide is much more than root dry weight increase. In this case doubling CO2 concentration comes along with 22 and 18% increase in shoot and root dry weight, while by tripling CO2 concentration these enhancement reaches to the 42 and 30% respectively.

Reducing irrigation water level causes a reduction in pods number, so the number of seeds in each bush decreases consequently. On the other hand, it has been shown that by increasing the $CO_2$ concentration from 400 to 800 ppm, pods and seeds number increase, but there is no significant difference between the number of pods and seed in 800 and 1200 ppm treatments. Furthermore, it has been shown that doubling and tripling $CO_2$ concentration brought 11 and 29% increase in 1000 seeds weights.

The results of this study show that by raising carbon dioxide concentration lentils' evapotranspiration decreases significantly. It has been shown that under deficit irrigation (50%WR), doubling CO2 concentration does not have any significant effects on evapotranspiration, which may be as a result of stomatal closer due to the water stress. However, tripling CO2 concentration in the crop environment has reduced evapotranspiration, although this effect is lower than other water irrigation treatments.

**Conclusion**

To sum up, increasing the environmental carbon dioxide concentration can increase crops dry matter, which consequently lead to enhancement of crop yield. On the other hand, reducing the amount of available water in crops root zone reduces plant production, which will decrease the effects of increasing carbon dioxide concentrations. Furthermore, increasing carbon dioxide concentration decreases the amount of evapotranspiration, thus crop water requirements, during the growing season, decreases too. Therefore, it can be said that increasing the carbon dioxide concentration, can reduce the adverse effects of water deficit.

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