Effects of carbon quantum dots on growth of *Brassica Juncea* under grow lights

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Abstract: *In this work, Carbon quantum dots (CQD) was prepared and applied to green mustard (Brassica Juncea).The objective of the work was to observe the effects of various CQD concentrations on growth of plants in an indoor hydroponics system. The physiological response of the plant was analyzed using the one-way ANOVA test (Duncan).This study found that CQD concentrations of 100 mg/L and 150 mg/L boost plant growth and photosynthesis rate inthe hydroponics system under grow light. Green mustard plants treated with 100 mg/L CQD showed a significant increase in plant height and net assimilation by 32%, and 23%, respectively. Correspondingly, plants treated with 150 mg/L CQD had a 29% increase in plant height and a 32% increase in net assimilation compared to control plants.*

***Keywords*:** Carbon quantum dot, plant growth, grow light, green mustard, statistical analysis

INTRODUCTION

Carbon quantum dots (CQD) have attracted the attention of researchers in the agriculture field due to its unique properties such as non-toxicity, biocompatibility, and environmentally friendly nature [1],[2]. CQDare zero dimension (0D) of carbon nanomaterial with a particle size of less than 10 nm [3],[4]. In comparisonto the control plant, the CQD treatment enhances the photosynthesis rate of plants and subsequently increases the plant growth. It has been reported, the CQD improved rice and maize plants' assimilation rate, stomatal conductance, height, and biomass [5]. This study uses a simple acid-free microwave-assistedprocedure to prepared CQD from empty fruit bunch biochar as an eco-friendly approach and evaluates their effect on green mustard at various concentrations. Previous MTT cytotoxicity studies also showed that concentration range used is non-toxic, thus, it is deemed safe and appropriate for use in agricultural applications [5].

MATERIALS AND METHODS

CQD was synthesized by microwave-assisted method as previously reported [6]. The CQD was then diluted to 50, 100, 150, 200 and 400 mg/L. Green mustard plants were treated with 1.5 mL of CQD at the various concentrations. The prepared CQD were applied in-vivo (spray) on the leaf surface for twice a month until the end of heading period. Distilled water was sprayed in the control treatment. In this experiment, a full spectrum grow light was used, the

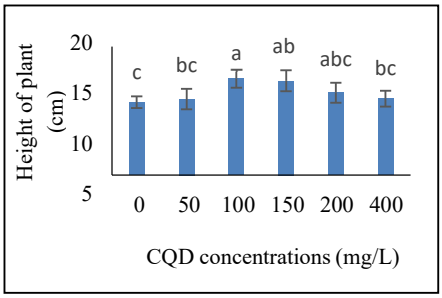
temperature of the system was maintained at 30°C and humidity maintained at 46% with a photoperiod of 12 h day/12 h night. The photosynthetic photon flux density (PPFD) was maintained at 130 μmol m^{-2} s^{-1} at the level of plant tips. The height and net assimilation of green mustard plants were measured at week 6.

STATISTICAL ANALYSIS

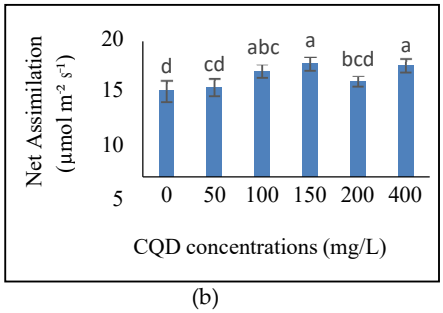
The data were interpreted using statistical analysis and represented in the bar chart form. Significant differences among all the treatments were analysed using the one-way ANOVA test (Duncan) at a significance level of 0.05, and all analyses were conducted in triplicate.

RESULTS AND DISCUSSION

As shown in Fig. 1(a), the plant height of 100, 150 and 200 mg/L CQD treated plants were significantly increased by 32%, 29% and 12%, respectively, compared to the control. Based on Fig. 1(b), 100, 150 and 400 mg/L CQD treated plants showed a higher net assimilation compared to other treatments. Each CQD concentration had varied net assimilation, whereby, 150 mg/L treatment increased the net assimilation by 32%, followed by 400 mg/L and 100 mg/L at 30% and 23%, respectively, when compared with control. Thedata assembled in the figures shows that all CQD treated plants significantly increased the plant height and net assimilation. The findings of 100 mg/L and 150 mg/L are nearly same, with significantly increasedplant height and net assimilation, but there is no significant difference between them. Increased CO_2 assimilation resulted in higher electron transport rates as CQD promotes electron transfer and assimilation
[5] [7]. The higher the plant's net assimilation, the higher the photosynthesis rate, which leads to increasedplant growth [8]–[10].



(a)



(b)

Fig. 1. (a) Height of plants. (b) Net assimilation of treated plants.

CONCLUSIONS

Based on the statistical analysis, it has been proven that CQD can enhance the plant growth as well as thephotosynthesis rate of the plant in an indoor hydroponics system under grow light.

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