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Response of Ozone Treatment on Dissolved Oxygen Levels, Growth and Yield of Cucumber Crop Grown in Hydroponics in Cooled Green House. Season: Winter (December-March)

Muthir S. Al Rawahy[1], Waleed S. Al Abri[1], Saif K. Al Qutati[1], Amal Al Zidi[1], Khalifa S. Al Subhi[1] & Jassem M. Al Harrasi[1]

[1] Directorate General of Agriculture &Livestock Research, Ministry of Agriculture, Fishers Wealth & Water Resources, Sultanate of Oman

Correspondence: Muthir S. Al-Rawahy, Directorate General of Agriculture & Livestock Research, Ministry of Agriculture, Fisheries, Wealth & Water Resources, Sultanate of Oman. Tel: 968-2689-6041. E-mail: marwan07@live.com

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Abstract

One of the main concerns related to closed systems is the potential spread of root pathogens. With the recirculation of nutrient solutions, ozone treatment was tested for the efficacy against plant pathogen (*Pythium*), dissolved oxygen levels, growth and yield of cucumber crop in hydroponic closed system during December-March 2020/21. Two nutrient solution feeding tank were used one with ozone treated and other without ozone treated in randomized complete design (RCD) with four replication. The results showed that no plants were affected with *pythium* diseases in both treatments Ozone treated and untreated during winter season. Significant ($p < 0.05$) differences were observed in chlorophyll content, as SPAD values between the two treatments and their interactions in cucumber. Also, no significant differences were observed in yield between the two treatments.

Keyword: ozone, cucumber, hydroponic, oxygen

1. Introduction

Root respiration is important for root growth and development, effecting water and nutrient uptake, which impact on plant productivity. One of the main concerns related to closed systems is the potential spread of root pathogens the aspect of which will not arise in winter as the crop do not get infected due to less than 25 degrees Celsius in Oman. Under low-oxygen stress, as observed under high temperature and with over-irrigation and/or poor substrate gas diffusion, plants absorb insufficient quantities of water and nutrients (Morard et al., 2000), experience slow growth and development (Urestarazu & Mazuela, 2005). Numerous reports have demonstrated the benefit of O_2 availability in the root zone above a certain threshold on plant health and productivity (Bhattarai et al., 2005). Zheng et al. (2007) reported that continuous growth of tomato in nutrient solution with high dissolved O_2 concentration ($\approx$ 40 ppm) could reduce root and plant development, but no mention was made of the effect on crop productivity. Ozone has been shown to be efficient in eliminating pathogens such as *Fusarium oxysporum* and tomato mosaic virus (Igura et al., 2004; Runia, 1994). With this method too, however, its efficiency is dependent on the dose and length of treatment. Oxygen deficiency in the root zone could lead to poor root and plant performance and an increase in the incidence of diseases and pests. Further, it is observed that if root zone oxygen dropped below 2.8 mg/L, the tomato plant roots would be much more susceptible to *Pythium* infection (Cherif et al., 1997). Root zone oxygen deficiency is of concern during hot summer days in greenhouses for example, Zheng (unpublished data) measured the root zone DO levels in a commercial cucumber greenhouse in Southwest Ontario, Canada in the summer of 2006 and found that the DO dropped to as low as 2 mg/L. In view of the above, the present investigation was carried out to know the effect of root-zone temperature on the dissolved oxygen level in the solution and on root and plant development, growth, yield and

quality of cucumber In view of the above information, the present study undertaken to investigate the response of Ozone treatment on dissolved oxygen levels, growth and yield of cucumber crop grown in hydroponics in cooled green house during winter season.

2. Materials and Methods

The experiment was conducted in one cooled Greenhouse (270 m^2) at Directorate General of Agriculture & Livestock Research in Barka South Batinah, during November 2020. Two feeding nutrient solution tanks were used one with ozone treatment which was applied at three times day; 7 am morning, 12 pm noon and 5 pm afternoon with doses of 10 mg/L through ozone generator and other one without ozone treatment. One variety of cucumber was used namely; IZZ F1. (Agrimax Spain) The seeds were sown in giffy-7 and seedlings were transplanted on 8/12/2020 after about a 10 days period. The plants inside greenhouse were arranged in Complete Randomized Design (CRD) with four replications as treatments with ozone and without ozone. The medium used was perlite which were filled in white ploy form pots size (23 × 23 × 20 cm). Number of pots per plots was 25 pots and number of plant in each pot were two plants making 50 plants per plot. Plot size was 8.4 m^2 (1.2 × 7 m). Automatic irrigation controller system was used to irrigate the plants which was settled from 7.00 am to 6.00 pm afternoon for 2 minutes every five minutes during the whole period of experiment. Three stock solutions; (SS1) contain of Calcium nitrate 12 kg with iron chilate 50 g diluted in 40 L of water, (SS2) NPK (12:12:36+TE) 12.5 kg and magnesium sulfate 6 kg diluted 40 L of water were prepared according to ICARDA-APRP recommendations (ICARDA-APRP stock solution) to feed the plants through feeding solution tank (400 gallon). The plants were feeding by measure the EC and pH of solution in feeding tanks which started at EC 2 ds/m and pH of 5.8 through Automatic Intelligent Hydroponic Doser. The EC of nutrient solution was increased as the plants growing up reached to 3 ds/m at the end of the experiment. Harvest started after 20 days from the date of transplanted for the both treatments fruits were harvested every two days. Dissolved oxygen levels in feeding tanks, first harvest, Picking Period (Days)**,** Number of fruits/plot**,** Fruit weight kg/plot and chlorophyll content were taken. The data were subjected to ANOVA in Randomized Complete Design (RCD) using Genstat Program 12th edition (VSN Intentional, 2011).

3. Results and Discussions

3.1 Effect of Ozone on Nutrient Solution Dissolved Oxygen Level

The result are presented in Figure 1 indicated the effect of treated nutrient solution with ozone on the dissolved oxygen levels which indicated significant ($p < 0.05$) differences between treated (ozone) and untreated nutrient solution. High levels of dissolved oxygen (DO) was with ozone treated nutrient solution at both time 8am and 12 pm and 2 pm 10 mg/L and 8.9 mg/L, and 8.6 mg/L while untreated nutrient solution gave less (DO) which was 8.7 mg/L and 7.9 mg/L and 8 mg/L. Although the difference in DO between two treatments was not big these could be explained by the temperature of nutrient solution of the two treatments which was ranged from 22.1 ^oC to 23.5 ^oC (Figure 2). Falah et al. (2010) found that in a high solution temperature (35 ^oC), effects were produced in the short and long-term and oxygen solubility was reduced. In both ozone treated nutrient solution and untreated nutrient solution the levels of DO in the nutrient solution were sufficient according to Holtman et al. (2005) who indicated that 3.5 mg/L dissolved oxygen represents a critical level, so that below these concentrations, a reduction of metabolic processes inside root cells may occur, resulting in reduced activity. In the ozonized system, the dissolved oxygen (DO) reached values of 8.25 mg/L during the first experimental day and 9 mg/L by the third day to the end of the test and also in both systems the concentration of dissolved oxygen was comparable, demonstrating the good functioning of ozone treatment and water recirculation (Nicoletto, 2017).

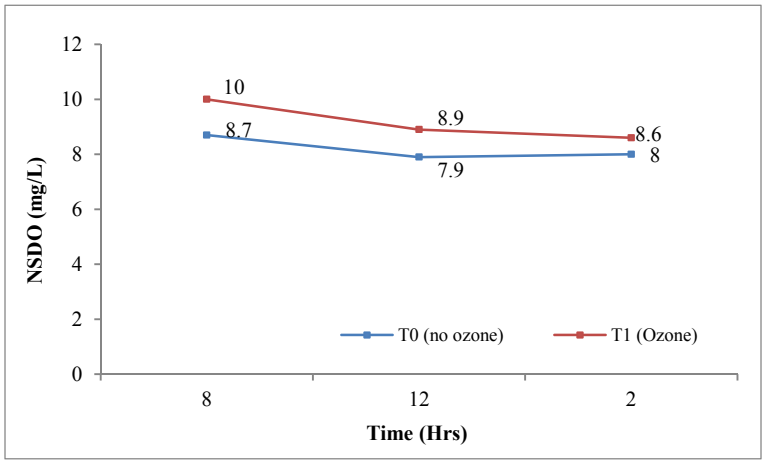

Figure 1. Effect of ozone treated and untreated nutrient solution on dissolved oxygen levels on cucumber crop grown hydroponically during spring cropping period (December-March) in greenhouse

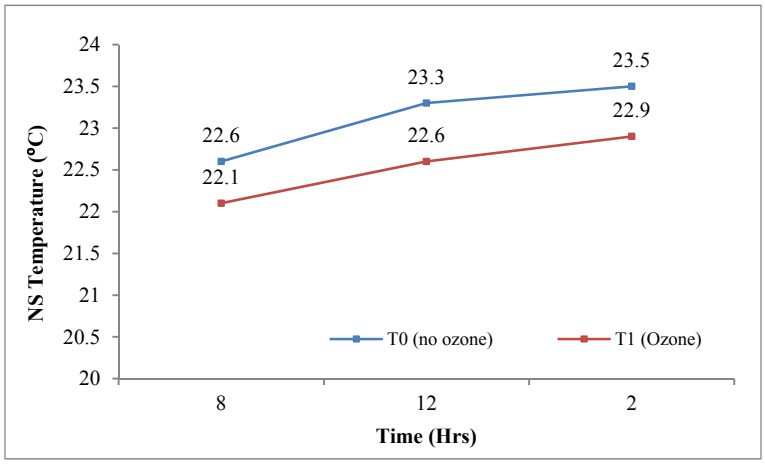

Figure 2. Effect of ozone treated and untreated nutrient solution on temperature levels on cucumber crop grown hydroponically during spring cropping period (December-March) in greenhouse

3.2 Chlorophyll Content (SPAD)

Significant ($p < 0.05$) differences were observed in chlorophyll content, as SPAD values, between the two treatment and their interactions of cucumber statistically. The chlorophyll content varied from 33.8 to 44.7 SPAD value for untreated nutrient solution whereas for ozone treated nutrient solution it was found varying from 35 to 46.7 SPAD values (Figures 3and 4). The results showed significant differences between the two treatments. There were no cultivar differences in chlorophyll a and total chlorophyll concentration in cucumber.

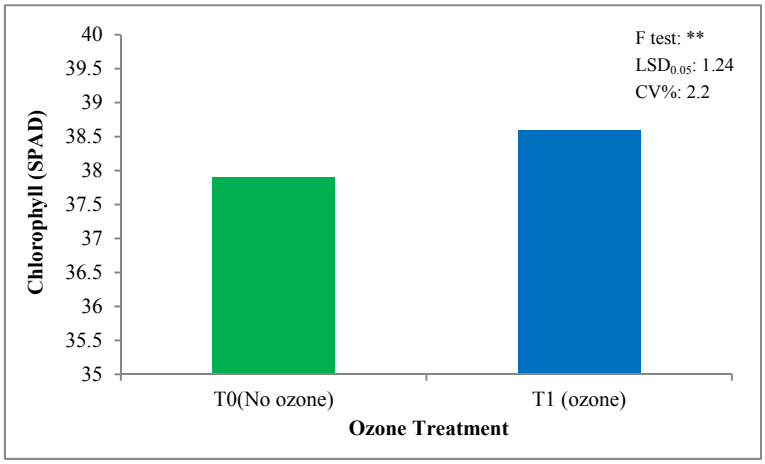

Figure 3. Effect of ozone treated and untreated nutrient solution on Chlorophyll content on cucumber crop grown hydroponically during spring cropping period (December-March) in greenhouse

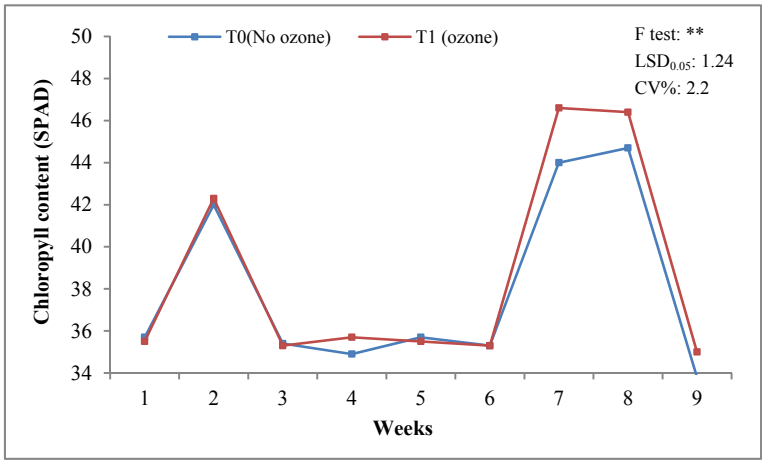

Figure 4. Effect of ozone treated and untreated nutrient solution on chlorophyll content on cucumber crop grown hydroponically during spring cropping period (December-March) in greenhouse

3.3 Yield Component and Yield

There were no Significant ($p < 0.05$) differences in fruit number/m^2 between the two treatments. However, treated nutrient solution plants were found to produce more number of fruits than untreated nutrients solution plants. Number of fruits ranged from 191/m^2 for untreated nutrient solution to 193/m^2 for Ozone treated nutrient solution plants. Also, no significant effects were detected between the treatments in yield (t/gh). Numerically high yield was obtained by Ozone treated nutrient solution plants (5.7 t/gh) in comparison with untreated nutrient solution (5 t/gh) (Table 1). In the study of Nicoletto (2017), yield and quality of plants obtained in the ozonized system did not significantly differ from the control plants. Further, in their study, there were no significant differences in chlorophyll content between the two treatments.

In the present study owing to absence of disease incidence during the course of experiment in winter season it was pursued that high air temperature can cause infection due to active of root rot causing pathogens. In this respect, the results showed that the plants treated with ozone and without ozone were not affected with *phytium* diseases because during winter season the air temperatures are low. Further, it was observed that temperature of nutrient solution (NST) of 22 ºC and 25 ºC improved growth characters (dissolved oxygen levels, chlorophyll content and uptake of nutrients). Thus the productivity of cucumber was found increased, although not significantly, in ozone treated as compared to that under untreated plants.

Table 1. Yield component and Yield of cucumber as affected by Ozone treated nutrient solution grown in hydroponic under cooled greenhouse at Rumais

Treatments	Fruit (No./m^2)	Yield (kg/m^2)	Yield (t/gh)
T0 (No Ozone)	191	20.3	5.5
T1 (Ozone)	193	20.9	5.7
Statistical Parameters			
F test	NS	NS	NS
$LSD_{0.05}$	11.7	1.28	0.35
CV%	3.5	3.6	3.6

4. Conclusion

The plants responded positively although not significantly to ozone in cucumber during growth and development in terms of yield and yield related parameters.

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