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Response of Ozone Treatment on Disease Incidence, Dissolved Oxygen Levels, Growth and Yield of Cucumber Crop Grown in Hydroponics in Cooled Green House. Season: Summer (June-August) at DGALR, Rumais

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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*), growth and yield of cucumber crop grown in hydroponic closed system during summer season (June-August) 2022. Two nutrient solution feeding tanks were used one with ozone treatment and other without ozone treatment in randomized complete design (RCD) with four replication. The results showed significant ($p < 0.05$) differences were observed between the treatments in diseases infections with *pythium* diseases. No significant ($p < 0.05$) differences were detected in chlorophyll content, as SPAD values and yield between the two treatment of cucumber statistically. Ozone treated plants produced more yield 4.0 ton/gh.

Keywords: ozone, cucumber, hydroponic, diseases, oxygen

1. Introduction

Root respiration is important for root growth and development, affecting water and nutrient uptake, which impacts on plant productivity. One of the main concerns related to closed systems is the potential spread of root pathogens. With the recirculation of nutrient solutions, a single infected plant could potentially be the source of infection for the entire crop (Postma et al., 2008). Oomycetous pathogens in particular, such as *Pythium* spp. and *Phytophthora* spp., are the most destructive diseases because of their production of motile zoospores that thrive in aquatic environments (Stanghellini & Rasmussen, 1994). 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) and run an increased risk for root diseases, such as *Pythium* root rot (Cherif et al., 1997). The anticipated result is a reduction in yield and quality or even a risk of crop failure due to root collapse. Although 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), very few. Zheng et al. (2007) reported that continuous growth of tomato in nutrient solution with high dissolved O_2 concentration (≈ 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.

2. Materials and Methods

The experiment was carried out in one cooled Greenhouse (270 m^2) at Directorate General of Agriculture & Livestock Research in Barka South Batinah, using soilless growing techniques (closed system) during summer season (June-August) 2022. Two feeding nutrient solution tanks were used one with ozone treatment and other one without ozone treatment. One variety of cucumber was used namely; IZZ F1 (Agrimax Spain). The seedling transplanted on 17/6/2022. The plants inside the 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 ployform 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 m × 7 m). Automatic intelligent hydroponic doser was used to irrigate the plants which was settled from 7.00 a.m. to 6.00 p.m. 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 lite of water, (SS2) NPK(12:12:36+TE) 12.5 kg and magnesium sulfate 6 kg diluted in 40 liter of water where prepared to feed the plants through feeding solution tank (400 gallon). The plants were feeding through Automatic intelligent hydroponic doser the EC of nutrient solution was increased from 2 ds/m as the plants growing up reached to 2.5 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 for first harvest, Picking Period (Days), Number of fruits/plot, Fruit weight kg/plot, dissolved oxygen levels, chlorophyll content and number of plants die in each treatment were counted every week and were taken and recorded. Finally the data were subjected to ANOVA in Randomized Complete Design (RCD) using Genstat Program 12th edition (VSN Intentional, 2011).

3. Results and Discussion

3.1 Pathogen Monitoring

Cucumber plants are susceptible to *Pythium* spp. (damping off) during the seedlings and vegetative stage, especially when the temperature is high and favorable for the disease to infect the plants. Sutton et al. (2006) reported that principal causal agents include *Pythium aphanidermatum*, *Pythium dissotocum*, members of *Pythium* group F, and *Pythium ultimum* var. *ultimum*. *Pythium* spp. root rot is ubiquitous and frequently destructive in almost all kinds of plants produced in hydroponic systems, including cucumber, tomato, sweet pepper, spinach, lettuce, arugula, and roses (Sutton et al., 2006). Many *Pythium* species have been reported to affect plants in hydroponic systems, including many species of *P. aphanidermatum* (Edson) Fitzp. *P. dissotocum* Drechsler, *P. ultimum* Trow var. *ultimum*, and members of *Pythium* group F (Favrin, 1988; Chérif et al., 1997; Martin & Loper, 1999; Owen et al., 2003). Development of severe root browning and root rot due to the pathogen in hydroponic crops produced in greenhouses often coincides with hot weather, when the temperature of the nutrient solutions and of the greenhouse in general is high. The present results in Figure 1 showed significant ($p < 0.05$) differences in *Pythium* spp. (damping off) infection between the treatments, plants treated with ozone were affected by the disease *Pythium* spp. by 0.125 while the non-ozone treated gave high levels of diseases incidences percentage which was 2.75 during this cropping period (June-August) therefore, the ozone treated plant gave positive effect in controlling the disease in the nutrient solution although the temperature of solution was high which was not cooled compared to untreated plants. Our findings agreed with Fortnum et al. (1997) who found that root necrosis caused by *P. myriotylum* in tobacco seedlings in a greenhouse float system was lowest when the nutrient solution temperature was 15 °C and highest at 30 °C. Also Owen-Going, Liu, and Sutton (unpublished) who found that roots of hydroponic peppers and chrysanthemums can be extensively colonized by *P. dissotocum* but remain almost symptomless at 16 to 18 °C, yet develop severe symptoms within minutes or hours when the temperature is raised to 24-28 °C.

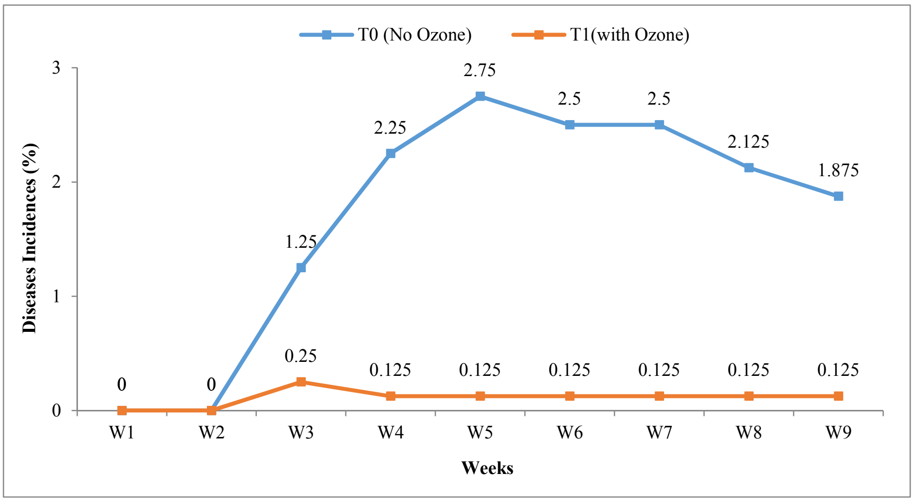

Figure 1. Effect of ozone treated and untreated nutrient solution on Disease incidence in cucumber crop grown hydroponically during summer cropping period (June-August) in greenhouse

3.2 Effect of Ozone on Nutrient Solution Dissolved Oxygen Level

The result presented in Figure 2 indicated the effect of treated nutrient solution with ozone on the dissolved oxygen levels which indicated no significant ($p < 0.05$) differences between treated (ozone) and untreated nutrient solution statistically. High levels of dissolved oxygen (DO) was with ozone treated nutrient solution at both time 8 a.m. and 12 p.m. and 2 p.m. 6.9 mg/L and 6.6 mg/L, and 6.7 mg/L while untreated nutrient solution gave less (DO) which was 6.2 mg/L and 5.9 mg/L and 6.0 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 27 °C to 30 °C without cooling nutrient solution. Falah et al. (2010) found that in a high solution temperature (35 °C), 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).

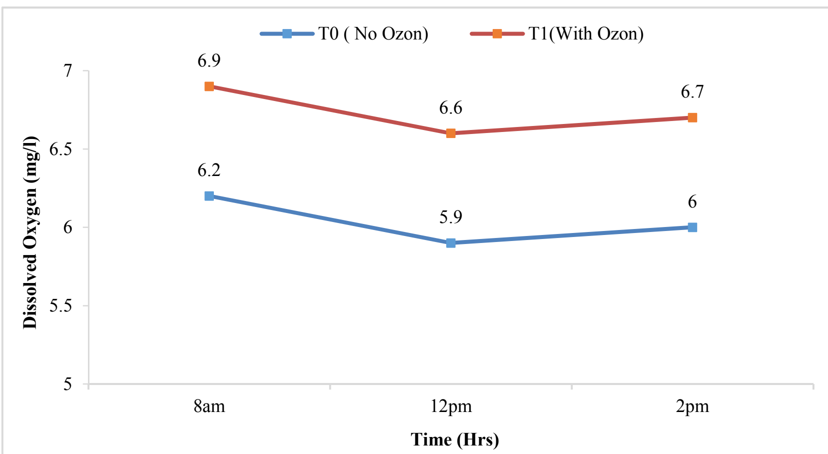

Figure 2. Effect of ozone treated and untreated nutrient solution on dissolved oxygen levels on cucumber crop grown hydroponically during summer period (June-August) 2022 in greenhouse

3.3 Chlorophyll Content (SPAD)

Color pigmentation in plants, especially chlorophyll, is important for plant growth and development. No significant ($p < 0.05$) differences were observed in chlorophyll content, as SPAD values, between the two treatment and their interactions of cucumber statistically. Chlorophyll content for Ozone treated nutrient solution was 47.8 SPAD value whereas for non-treated nutrient solution was 46.6 SPAD values (Figures 3 and 4). Although the results showed significantly differences between the two treatments statistically numerically was almost same or small differences which are in agreement with the results obtained by Madhoolika et al. (1993) who reported that Ozone fumigation had no effect on the concentration of chlorophyll a or total chlorophyll also There was no cultivar difference in chlorophyll a and total chlorophyll concentration in cucumber). Ozone fumigation caused a partial inactivation of PS II, as revealed by decreased variable fluorescence (Fv) (Madhoolika et al., 1993).

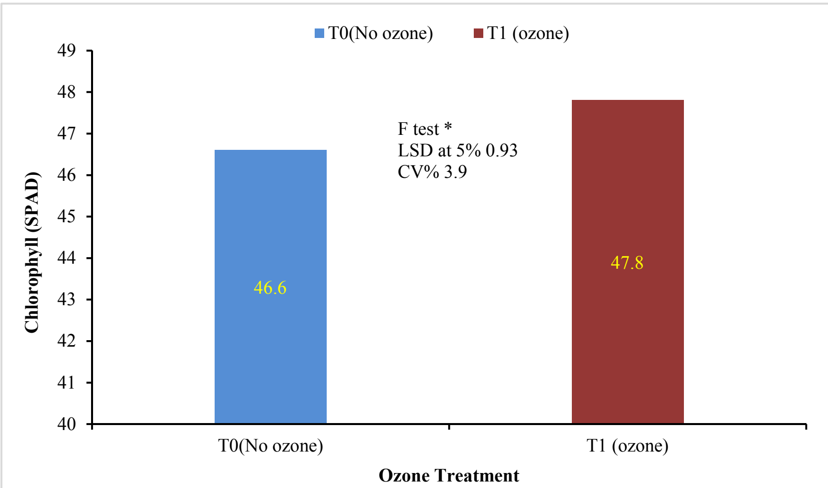

Figure 3. Effect of ozone treated and untreated nutrient solution on Chlorophyll content on cucumber crop grown hydroponically during summer cropping period (June-August) in greenhouse

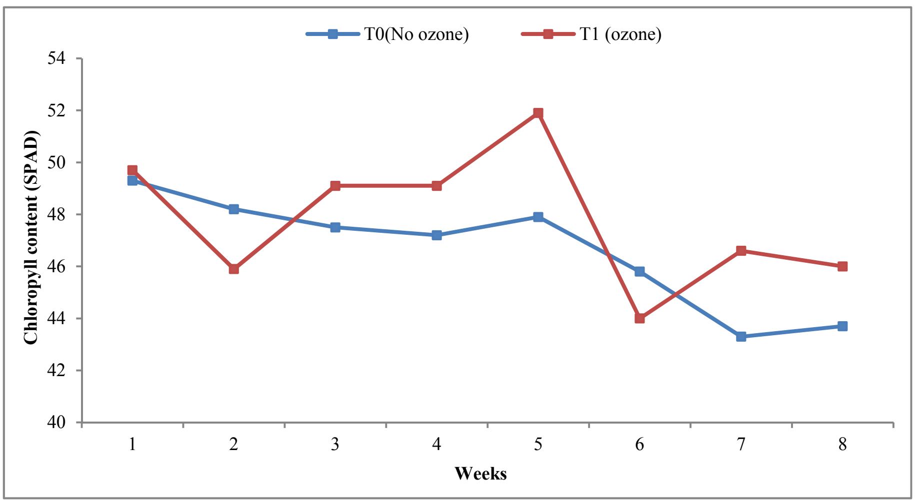

Figure 4. Effect of ozone treated and untreated nutrient solution on chlorophyll content on cucumber crop grown hydroponically during summer cropping period (June-August)

3.4 Yield Component and Yield

No Significant ($p < 0.05$) differences in fruit number/m^2 were revealed between the two treatments. Treated nutrient solution plants produced more number of fruits than untreated nutrients solution plants. Number of fruits varied from 171/m^2 to 176/m^2 for untreated nutrient solution and ozone treated nutrient solution plants respectively. No significant differences were observed between the treatments in yield ton/gh statistically. High yield was produced by Ozone treated nutrient solution plants 4.0 t/gh while untreated nutrient solution gave 3.6 ton/gh Table 1. Yield and quality of plants obtained in the ozonized system did not significantly differ from the control plants (Nicoletto, 2017).

Table 1. Yield component and Yield of cucumber as affected by Ozone treated nutrient solution grown in hydroponic under cooled greenhouse at Rumais during summer (June-August) 2022

Treatments	Fruit (No./m^2)	Avg. fruit wt (g)	Yield (kg/m^2)	Yield (t/gh)
T0 (No Ozone)	171	76.1	13.1	3.6
T1 (Ozone)	176	81.4	14.4	4
Statical parameters				
F test	NS	NS	NS	NS
$LSD_{0.05}$	42.9	10.2	4.8	1.3
CV %	5.7	7.5	7.2	7,2

4. Conclusion

(1) Utilized new away (Ozone treatment) of protection against diseases infections for cucumber grown in hydroponics.

(2) Reducing using of pesticides in protected agriculture as results reduce cost of inputs.

(3) Producing Healthy and quality product as results healthy for Human consumption.

(4) Protect environment from pollution.

(5) Increasing dissolved oxygen in nutrient solution as results increase aeration in the roots atmosphere of cucumber crop in hydroponics.

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