

Effect of Chlorine Dioxide on Pepper Plant Vigor

Libby R.R. Davies, Danielle D. Treadwell, Daniel J. Cantliffe, and Michael R. Allgood
Department of Horticultural Sciences, University of Florida



LibbyDavies@ufl.edu

ABSTRACT

Recycled irrigation water is easily contaminated with plant pathogens and algae, therefore water must be sanitized prior to recirculation. Chlorine dioxide (ClO_2), a common disinfectant used to treat municipal water and postharvest dump tanks, has been proposed as a disinfectant for recirculated irrigation systems. Little prior research has been performed to determine if this chemical is appropriate to use in irrigation on greenhouse specialty crops. The objective of this study was to determine the effects of ClO_2 on the vigor of bell pepper plants at different concentrations (0, 10, 20, and 40 ppm) and in two different soilless medias (perlite and pine bark). Plants were transplanted in the University of Florida Protected Agriculture Project greenhouse on 5-Nov. The ClO_2 application occurred 11 days after transplanting. Pepper plant height was measured weekly for six weeks. Leaf area, fresh mass, and dry mass of plants was measured at the end of six weeks. Data were analyzed using SAS (v.9.2). There was no interaction between media and ClO_2 concentration, therefore main effects are reported. For the concentrations examined, results indicate that increasing concentrations of ClO_2 in the irrigation water is negatively associated with plant height, leaf area, fresh mass and dry mass. For all parameters, peppers produced in perlite were less vigorous than peppers produced in pine bark.

BACKGROUND AND OBJECTIVES

Chlorine dioxide has been proposed for use as a disinfectant in recirculating irrigation systems in greenhouses because it has fewer harmful byproducts than chlorine, is active over a wide pH range, is effective against chlorine resistant pathogens, and unlike UV light and Ozone an oxidizing residual can be maintained in the water (3). Chlorine dioxide has not been thoroughly tested to treat irrigation water on greenhouse vegetables. A previous study has shown that ClO_2 applied 1-5 times at a concentration of 2.6 ppm slightly reduced the size of radish seedlings (2), however little further research has been done to assess the plant response to this chemical.

The aim of this research was to determine the impacts that high concentrations of ClO_2 have on pepper vigor in a greenhouse environment. The present study investigates the plant response at concentrations of 0, 10, 20, and 40 ppm of ClO_2 . Experiments are being performed in a greenhouse setting using bell pepper (*Capsicum annuum*) as a test plant due to its sensitivity to chlorine treatments.

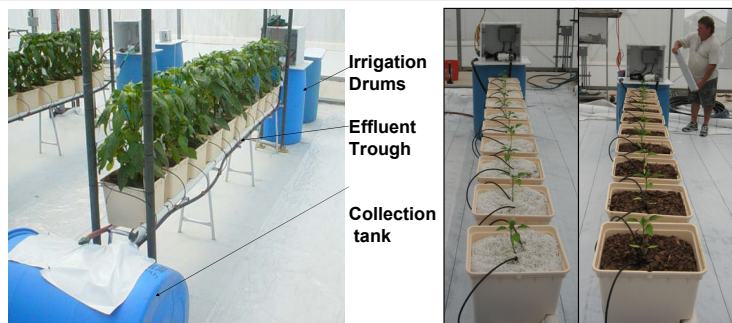


Fig.1 Irrigation system: Left: Water, fertilizer, and ClO_2 are held in 55 gal tanks. Effluent water is collected in a trough and stored in a 55 gal tank until recycled into irrigation tanks. Right: Peppers planted into perlite (right) and pine bark (left).

MATERIALS AND METHODS

Treatments included four concentrations of ClO_2 (0, 10, 20, and 40) and two medias: perlite and pine bark. Treatments were applied to plots of ten plants each, and were randomized and replicated three times. The greenhouse was divided into 24 plots, each having an irrigation system to supply water, fertilizer, and ClO_2 to the plants.

Six-week-old pepper seedlings, *Capsicum annuum*, cv Legionnaire, were transplanted into the greenhouse on 5 Nov, 2009. Plants were irrigated for 30 seconds every 45 minutes between 7am and 5:30 pm with 33 ml of irrigation per event. The chlorine dioxide treatments were added to the irrigation water on 16 Nov, 2009. Plant height was measured once weekly. After four weeks of being irrigated with the Chlorine dioxide solution, plant vigor measurements were taken: total leaf area (LI-3100, LI-CORE), and fresh and dry mass of roots and shoots. Proc glm was used for mean all mean comparisons when treatments differed ($p < 0.05$), and Proc nlin was used to fit the quadratic plateau models for plant vigor parameters (2).

Acknowledgements:

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RESULTS

No interaction between media and ClO_2 concentration was observed, however the main effects of media and concentration rate were significant ($p < 0.05$) across all parameters measured. Pepper vigor was reduced in perlite media compared to pine bark for all parameters measured (Table 1). Media type and concentration of ClO_2 had a significant influence on root mass. Plants grown in pine bark consistently had greater leaf area, fresh and dry mass (Fig 2). As concentration of ClO_2 increases leaf area, dry mass, and fresh mass decrease quadratically to a point, then level out linearly (Figure 3). By the end of six weeks in the greenhouse, plants irrigated with different concentrations of ClO_2 developed to significantly different plant heights (Figure 4 and 5).

Table 1. Media Impact on Pepper Vigor

Media	Leaf Area (cm ²)	Fresh shoot mass (g)	Fresh root mass (g)	Dry shoot mass (g)	Dry root mass (g)
Pine Bark	644.6(115.9) a	34.4 (5.5) a	15.6 (1.7) a	3.4 (0.5) a	0.8 (0.1) a
Perlite	253.0 (69.8) b	15.05(4.1) b	6.4 (1.4) b	1.8 (0.4) b	0.5 (0.1) b
LSD	140.4	5.7	1.8	0.5	0.1

Values are means (SE) over 6 plots. Values in the same column followed by different letters are significantly different ($p < 0.05$).

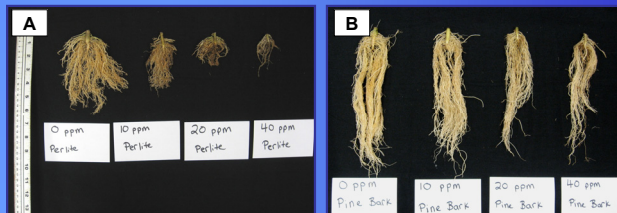


Fig. 2: Representative roots from perlite (A) and pine bark (B) media grown in 0, 10, 20 and 40 ppm of ClO_2 .

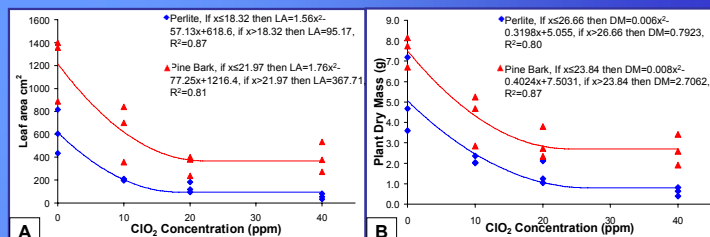


Fig 3. Leaf area (cm²) (A) and plant dry mass (g) (B) in response to ClO_2 concentration. Fresh mass (not shown) follows a similar trend.

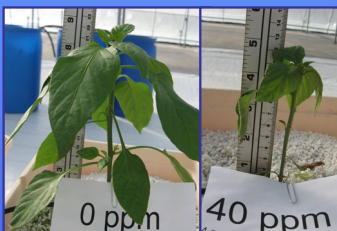


Fig. 4: Height Comparison. Two representative peppers grown in perlite two weeks after ClO_2 application.

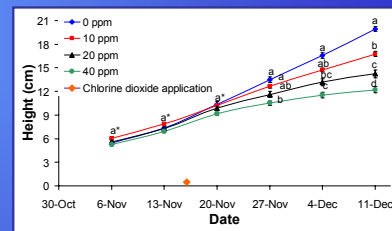


Fig. 5: Weekly mean height of pepper plants. Means with different letters are significantly different at $P \leq 0.05$ (a* = all means are statistically similar).

CONCLUSIONS

- Peppers had greater mass, leaf area, and height when produced in pine bark rather than perlite.
- Increasing concentrations of ClO_2 negatively impacted pepper leaf area, fresh mass, dry mass and height.
- Concentrations of ClO_2 above 10 ppm should not be irrigated onto peppers, however lower rates between 0-10 ppm may protect plants with minimal impacts on pepper vigor and yield.

References:

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