Effects of Hydrogen Peroxide on Hydroponic Lettuce Grown with Conventional and Organic Fertilizers

Vanessa M. Lau & Neil S. Mattson
Department of Horticulture, Cornell University, Ithaca, NY 14853

Background & Objectives

With organic agriculture and hydroponics growing in popularity, implementation of both techniques is becoming widespread. Benefits of using organic fertilizers in hydroponics include a lesser environmental impact since conventional fertilizers are nonrenewable and organic fertilizers can be generated from products otherwise directed toward the waste stream.

One of biggest detriments to organic hydroponics is that yield tends to be lower than that of its conventional counterpart. This is often attributed to biofilm formation in reservoirs that contains which compete with crops for resources such as oxygen, and nutrients. The biofilm tends to cling to roots limiting dissolved oxygen (DO) availability. Hydrogen peroxide (H_2O_2) is a disinfectant that decomposes to form oxygen (O_2) and water (H_2O), therefore it may control biofilm and increase DO, but it could also damage plant roots.

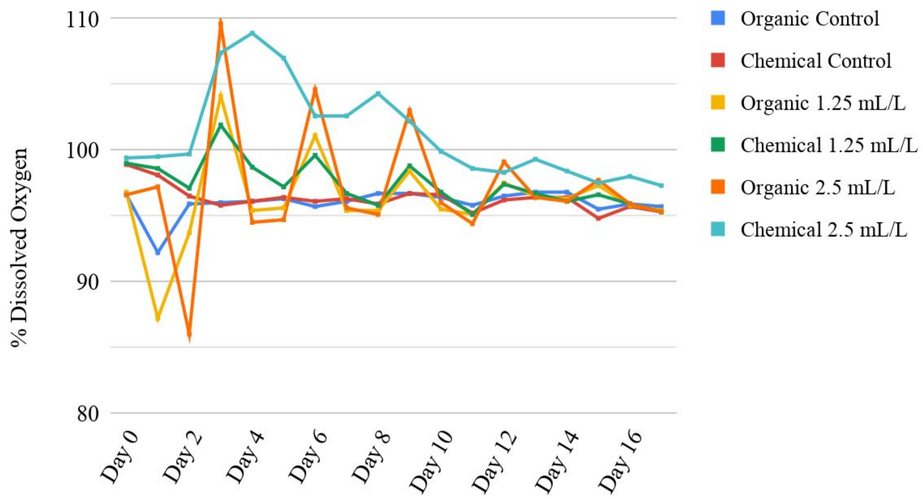
The objective of this experiment was to determine the effects of H_2O_2 as a disinfectant to increase crop yield for conventional or organic fertilizers. A second objective was to determine the effect of H_2O_2 on DO.

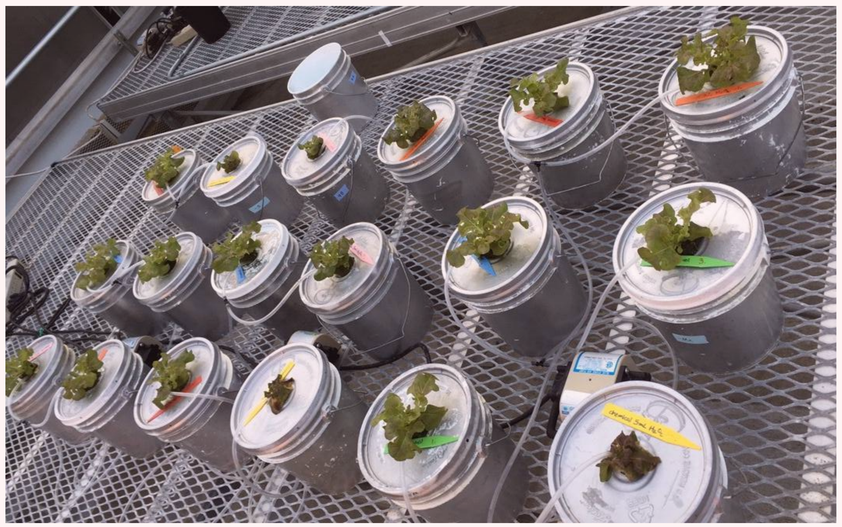
Methodology

The experiment was conducted in a glass greenhouse at room temperature and with ambient light. Three different treatments consisting of a control, 1.25 mL/L, and 2.5 mL/L of H_2O_2 were added to aerated 4-L deep water culture reservoirs that were fertilized with either organic (4-4-1, Drammatic One fish emulsion) or inorganic nutrients (21-5-20), both applied at 150 mg/L N. Three replicates for each treatment and each fertilizer were prepared resulting in a total of eighteen reservoirs with one head of oakleaf lettuce being grown in each for 18 days.

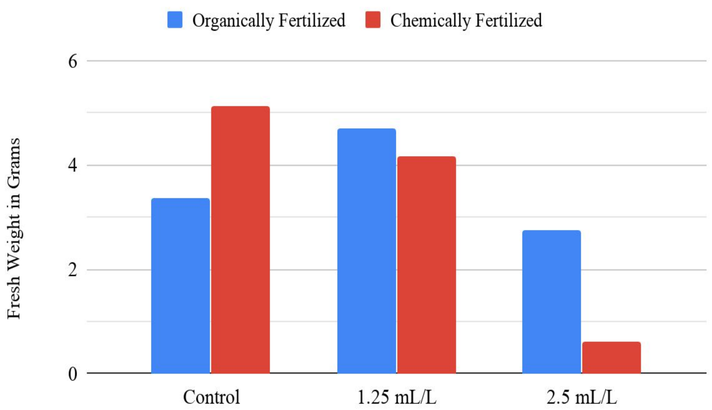
Each day, EC was adjusted and maintained between 1.5-1.7 mS/cm, pH was kept between 5.5-6.0, and dissolved oxygen levels were recorded. Every three days, H_2O_2 treaments were reapplied and plant height, leaf length, and root length were measured. At the end of the experiment, fresh weight of the lettuce leaves were recorded.

Dissolved Oxygen Measurements

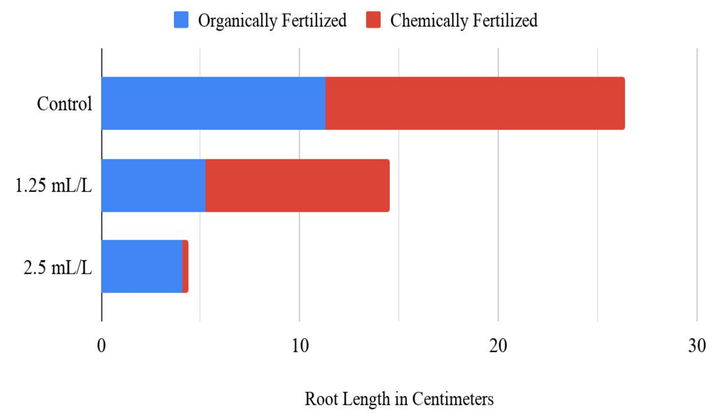




Final Lettuce Fresh Weight



Final Lettuce Root Length



Results & Discussion

While it was predicted that all of the reservoirs treated with hydrogen peroxide would yield larger, more robust lettuce heads, that was not the case. The results of this trial showed that when added to conventional fertilizers, doses of 1.25 mL/L and 2.5 mL/L of H_2O_2 stunted the growth of or wilted the heads of lettuce, respectively. However, when applied to organic fertilizers, doses of 1.25 mL/L H_2O_2 significantly increased yield almost matching that of the conventionally fertilized control. But at a dose of 2.5mL/L H_2O_2 on organic treatments, growth was also stunted. Though some biofilm visibly persisted, no diseases developed in the root zones and though the addition of H_2O_2 seems to have negatively impacted root development, the effects on conventionally fertilized treatments were much greater.

The biweekly addition of H_2O_2 to hydroponic reservoirs spiked dissolved oxygen levels upon application, but quickly declined in the following days. As time went on, dissolved oxygen levels seemed to stabilize and H_2O_2 treatments had lessened effects.

Conclusion

This experiment showed that in low doses, the addition of H_2O_2 increased the overall yield of organically fertilized hydroponic oakleaf lettuce but was detrimental to the growth of conventionally fertilized treatments. Future trials will be able test different concentrations of H_2O_2 to find an optimal dosage and application rate to see if organically fertilized hydroponic lettuce growth could surpass that of conventionally fertilized lettuce, making organic hydroponics more desirable and efficient.

H_2O_2 at the applied dosage/frequency was inefficient at clearing biofilm and can contribute to root damage, though root length did not directly correalate with yield. The primary benefit of H_2O_2 may be in increasing DO.