

Effects of controlled electric conductivity fluctuations on hydroponically grown basil

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Introduction

Basil is a valuable culinary herb cultivated worldwide, known for its aroma, rapid growth, and high demand. With the increase in controlled environment agriculture and soilless systems, such as hydroponics and vertical farming, nutrient management has become critical to ensuring high yields and consistent quality in basil production (Saha et al., 2016). The electrical conductivity (EC) of the nutrient solution is one of the most important parameters affecting plant growth, nutrient uptake, and overall crop performance in hydroponic systems.

Electrical conductivity reflects the concentration of dissolved solids in a nutrient solution. Maintaining an optimal EC ensures that plants have access to sufficient nutrients without creating stress or a nutrient imbalance. Hosseini et al. (2021) demonstrated how EC levels significantly influence plant growth and physiologically high or low EC can reduce growth rate. The study identified optimal EC ranges that maximize growth while minimizing nutrient waste, suggesting that precise EC management can improve both yield and sustainability. The purpose of this project was to determine if controlled EC fluctuations could induce stress-based growth.

Materials and Methods

Three Harvest Lite Aerogardens (Figure 1), a type of deep-water culture hydroponic planter, were acquired for this project. Prior to the start of growth, seeds of Genovese basil were germinated for ten days. After germination, three seeds were placed in each of the eighteen pods, with six pods allocated to each Aerogarden. The pods were designated as either a control, low-fluctuation, or high-fluctuation group. Plants were fed a nutrient solution of General Hydroponics CaMg⁺ and Mission Fertilizer GROW 3-1-2 Organic Fertilizer. The pH was manually adjusted with General Hydroponics pH Up and General Hydroponics pH Down. The EC and pH of the Aerogardens were measured with a YINMIX EC/pH meter.

The pump and LED lights in the Aerogardens activated on a programmed schedule to ensure consistency. The Aerogardens were kept in a room temperature environment, away from natural lighting. Every three days over an eight-week period, the EC of the low-fluctuation and high-fluctuation groups were adjusted to cycle between low, moderate, and high EC states. Daily checks were made to assure the plants stayed within the proper ranges of pH and EC.

Figure 1 (right): Picture of Aerogarden setup. The plastic caps were meant to protect the basil seedlings from damage during early growth. The LED lights on the top of the Aerogarden were set to an internal timer so that they would activate automatically alongside the internal pump.

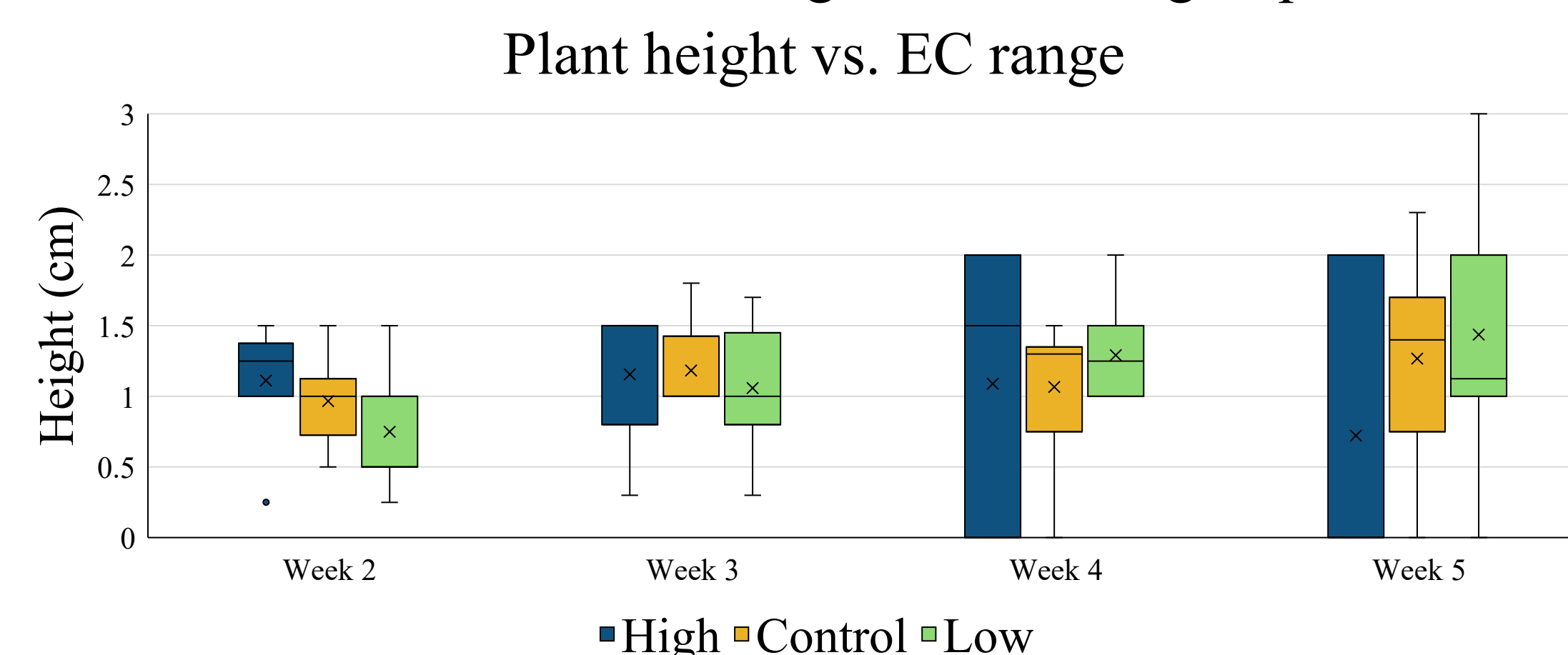


Materials and Methods (continued)

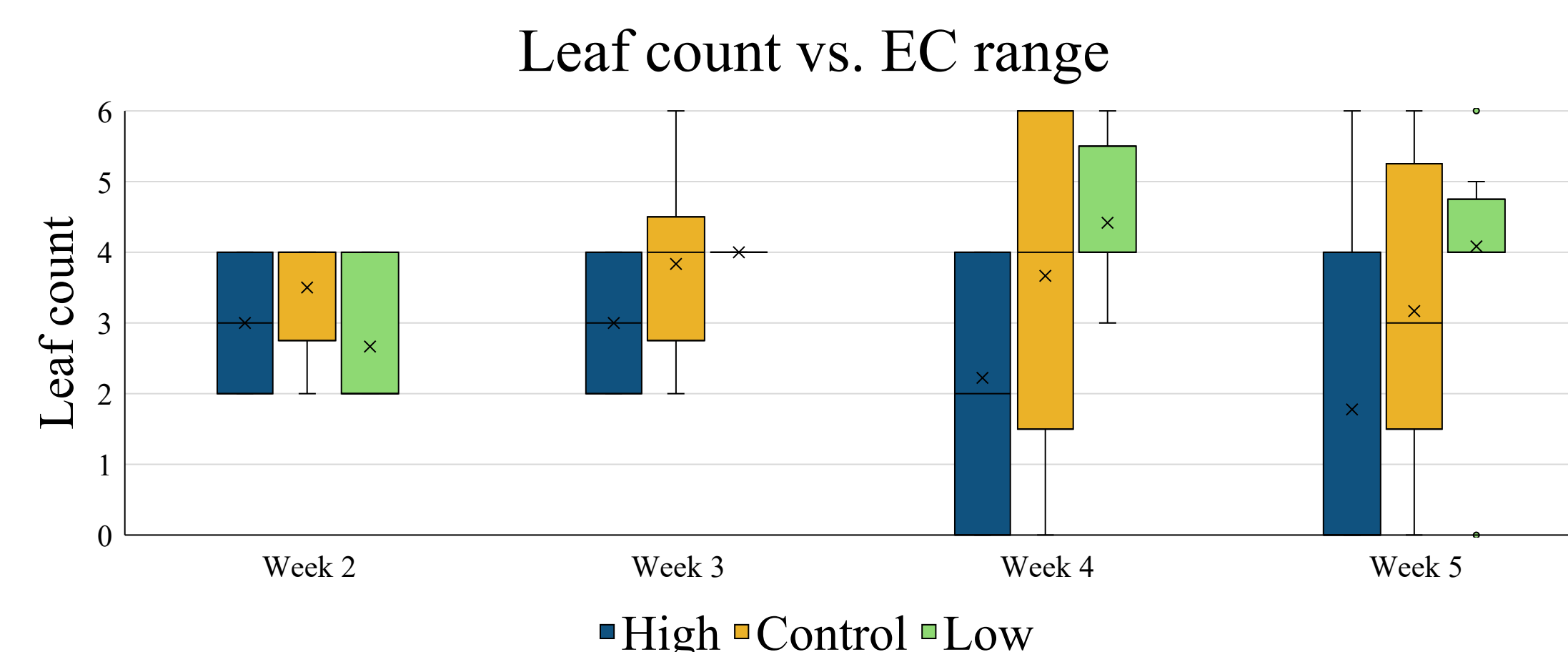
The control group was kept at 700 ± 100 ppm; the low-fluctuation group cycled through states of 600 ± 100 ppm, 700 ± 100 ppm, and 800 ± 100 ppm; the high-fluctuation group cycled through states of 400 ± 100 ppm, 700 ± 100 ppm, and 1000 ± 100 ppm. All groups were kept at a pH of 6.0 ± 0.2 . Plant height, leaf number, and leaf area of each plant recorded taken weekly to track growth.

Results

During the five-week growing period mean plant height did not appear to change, however, within group variability increased as time went on (Graph 1). In week two the high-fluctuation group had a greater mean plant height, whereas in week five the low-fluctuation group resulted in the greatest mean plant height. During the five-week growing period mean leaf number did not appear to change, however, within group variability increased as time went on (Graph 2). In week one there was more consistency between groups as opposed to weeks four and five. During these two weeks there was an observed difference between the mean leaf numbers of the low and high-fluctuation groups.



Graph 1 (above): Graph for the plant height vs. EC range over time. Three seeds were planted in each of the six cups. Throughout the experimental period not all plants survived. Week one was not included due to no growth evident at that time. Variability of plant height increased over time.



Graph 2 (above): Graph for the leaf number vs. EC range over time. Three seeds were planted in each of the six cups. Throughout the experimental period not all plants survived. Week one was not included due to no growth evident at that time. Variability of leaf count increased over time.

Discussion

The results of this study suggest that basil plants exposed to low EC fluctuations showed trends toward greater growth and development compared to plants exposed to constant or highly fluctuating EC conditions. While average plant height and leaf number did not show large overall changes during the monitored period, differences between groups became more noticeable over time, particularly during the later weeks of the experiment. Increased variability within groups also suggested that EC fluctuations may influence plant growth differently between individual plants.

Several sources of experimental error and study limitations affected the reliability of the data. During weeks six through eight, the experiment coincided with spring break, resulting in the plants not being monitored or maintained for approximately 12 days. Because regular EC adjustments, environmental monitoring, and maintenance procedures could not be performed during this time, the data was excluded from analysis. The lack of supervision likely contributed to inconsistent growing conditions, including possible temperature fluctuations, nutrient imbalance, and biofilm formation within the Aerogarden systems. Another limitation of the experiment was the inability to obtain a valid quantitative measurement of leaf area. Although leaf area was intended to serve as an indicator of plant productivity and health, there was not a standardized or reliable method available to accurately measure total leaf area throughout the experiment. As a result, leaf area data could not be consistently analyzed or compared between groups.

Additional sources of experimental error may have included biological variability between plants, uneven nutrient uptake, differences in root development, and inconsistencies in EC readings depending on the timing of measurements relative to pump activation. Future studies should incorporate automated monitoring systems, more consistent maintenance schedules, and digital image analysis software for more accurate leaf area measurements and improved experimental reliability.

References

- Hosseini, H., Mozafari, V., Roosta, H.R., Shirani, H., van de Vlasakker, P.C.H., & Farhangi, M. (2021). Nutrient use in vertical farming, optimal electrical conductivity of nutrient solution for growth of lettuce and basil in hydroponic cultivation. *Horticulturae*. 7(9). Article 283. <https://doi.org/10.3390/horticulturae7090283>
- Saha, S., Monroe, A., & Day, M. R. (2016). Growth, yield, plant quality and nutrition of basil (*Ocimum basilicum* L.) under soilless agricultural systems. *Annals of Agricultural Sciences*. 61(2). 181–186. <https://doi.org/10.1016/j.aos.2016.10.001>