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Interactive effects of white led light, vapour pressure deficit, and root zone salinity on growth and nutrient uptake of hydroponically grown quinoa

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Abstract

To date, little is known about the suitability of white light emitting-diodes (LEDs) for the plant production in controlled-environmental agriculture. The objective of this study was to evaluate the suitability of white LEDs for hydroponic quinoa production under moderate salinity (100 mM NaCl) at contrasting vapour pressure deficit (VPD) regimes, using ceramic metal halide lamps (CMH) as a reference. Quinoa (*Chenopodium quinoa* Willd., cv. Vikinga) was grown hydroponically in a greenhouse at two different salinity levels (0 and 100 mM NaCl) and two contrasting VPD levels (high 3.4 and low 0.6 kPa). Plant dry biomass and leaf area were measured alongside evapotranspiration and SPAD. Sodium (Na^+), and Potassium (K+) concentrations of the plants were analysed. Biomass allocation (leaf:stem ratio) and K+/Na^+ ratios under salinity were calculated.

Plants grown under LED lights produced similar biomass to CMH light under high VPD conditions at both salinity levels, indicating that LED lighting can sustain quinoa growth under dry atmospheric conditions. Salinity of 100 mM did not reduce the plant biomass under both light sources showing the plant's tolerance to root zone salinity of 100 mM NaCl. Leaf area under LED light was smaller than under CMH light, however leaf mass per area was higher and leaves were greener under LED illumination. Plants grown under LED light produced bushy plant types with shorter stems than under CMH light which was reflected in the higher leaf-stem ratio for the plants grown under LED light. Evapotranspiration and sodium uptake were lower under LED light, whereas potassium uptake was similar under both light sources. K+/Na^+ ratios did not show any differences across plant parts (root, stem, and leaves) under high VPD.

Under low VPD conditions, plants grown under LED light showed a significant reduction of evapotranspiration, K+ uptake, and growth compared to CMH light conditions. This underlines the importance of atmospheric humidity for plant growth under LED lighting. Overall, the results show that LED lighting is suitable for hydroponic quinoa production under moderate salinity in greenhouse cultivation, provided that dry conditions are maintained to support the potassium nutrition and growth stability.

Keywords: Biomass, CMH, Greenhouse, Hydroponics, K+/Na^+ ratio, LED, quinoa, Salinity, VPD

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