Growth and Productivity of Vegetable Crops as Affected by Nutrient Management Practices in an Aquaponics System

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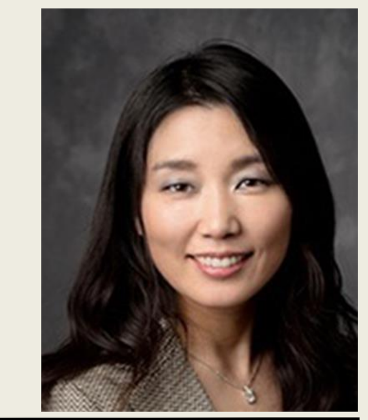

Introduction

- Aquaponics is a production system that integrates aquaculture and hydroponics by recirculating residual nutrients resulted from fish waste for crop production.
- Optimizing nutrient management practices is critical to improve crop productivity in aquaponics, and different nutrient management practices may affect nutrient availability in waste water and even crop performance.
- Although many different vegetable crops have been suggested for aquaponics systems, limited information is available on their growth performance according to their physiological groups and growth characteristics.

Objectives

This study was conducted to examine the effect of two different nutrient management practices on water quality and growth performance of 10 vegetable species:

- 1. Leaf green: Pac Choi (*Brassica rapa* var. *chinensis*), Swiss chard (*Beta vulgaris*), Bekana (*Brassica rapa* var. *chinensis*), Lettuce (*Lactuca sativa*), Mizuna (*Brassica rapa* var. *japonica*), Mustard (*Brassica juncea*), Amaranth (*Amaranthus*);
- 2. Herb: Basil (*Ocimum basilicum*), Chia (*salvia hispanica*);
- 3. Fruity: Cherry tomato (*Solanum lycopersicum*).

Materials and Methods

Figure 1. Aquaponics Systems in the Purdue HORT Greenhouse.

- Water quality parameters (temperature, °C; pH; electrical conductivity, EC, μS·cm^{-1}; dissolved oxygen, DO, mg·L^{-1}) were measured daily. The pH was adjusted at around 7. Water was sampled for ammonia, nitrite, nitrate, and phosphate every four days. Crop growth parameters were measured weekly, including plant height, leaf length and leaf number, leaf color, leaf temperature, photosynthetic rate (Pn) and transpiration rate (Tr).

Results

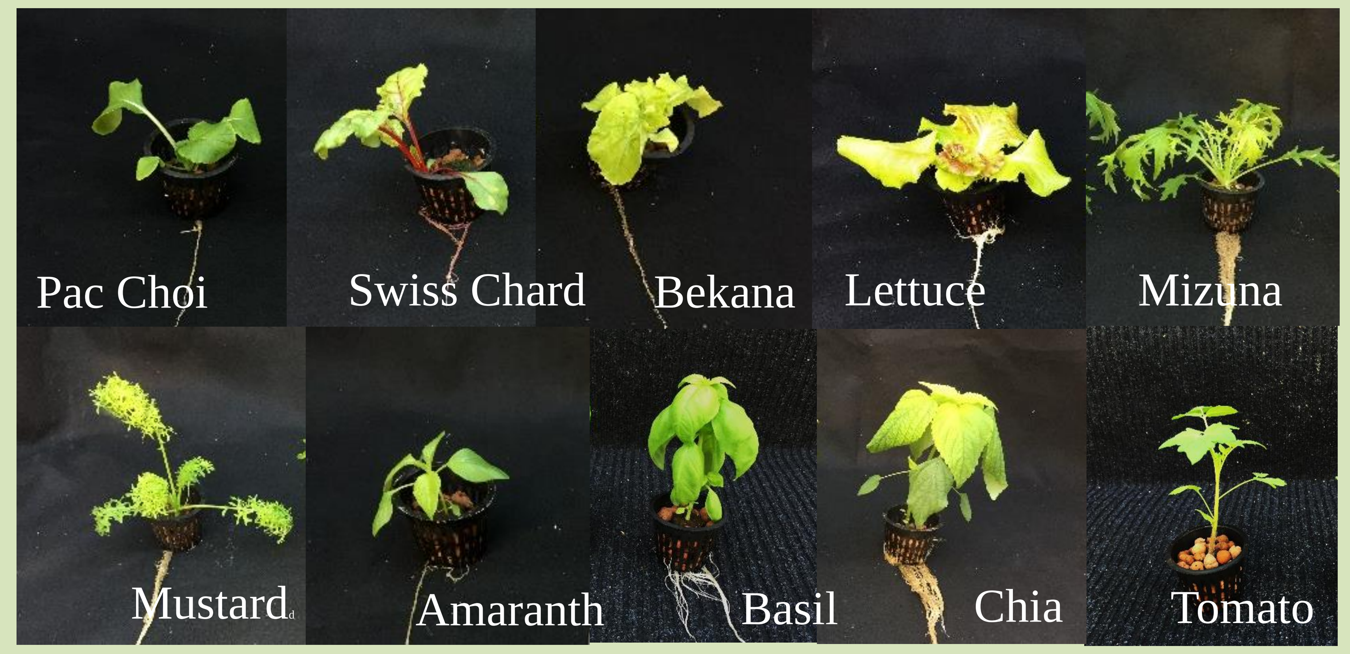

Figure 2. Plant materials used in each feeding scheme.

Table 1. Two feeding schemes in the study.

Treatment	Daily Uniform Feeding (DUF)	Daily Increasing Feeding (DIF)
Feeding amount (g)	1800	1800
Initial feeding amount (g)	60	40
Daily increment amount (g)	0	5

*Fish were fed daily using two different feeding schemes: daily uniform feeding (DUF) and daily increasing feeding (DIF) by 1% fish fresh weight.

Table 2. Average water quality parameters levels and water consumption in DUF and DIF aquaponics.

Treatment	DO (mg/L)	pH	Temperature (⁰C)	FCR	Water Consumption (L)
DUF	7.14 a	6.85 a	26.8 a	1.08 a	228 b
DIF	7.05 a	6.79 a	27.5 a	0.92 a	269 a

*Means within column followed by different letters are significantly different based on Tukey's honestly significant difference test (α =0.05).
*FCR (food conversion ratio) = consumed food amount/(final fish mass-initial fish mass).

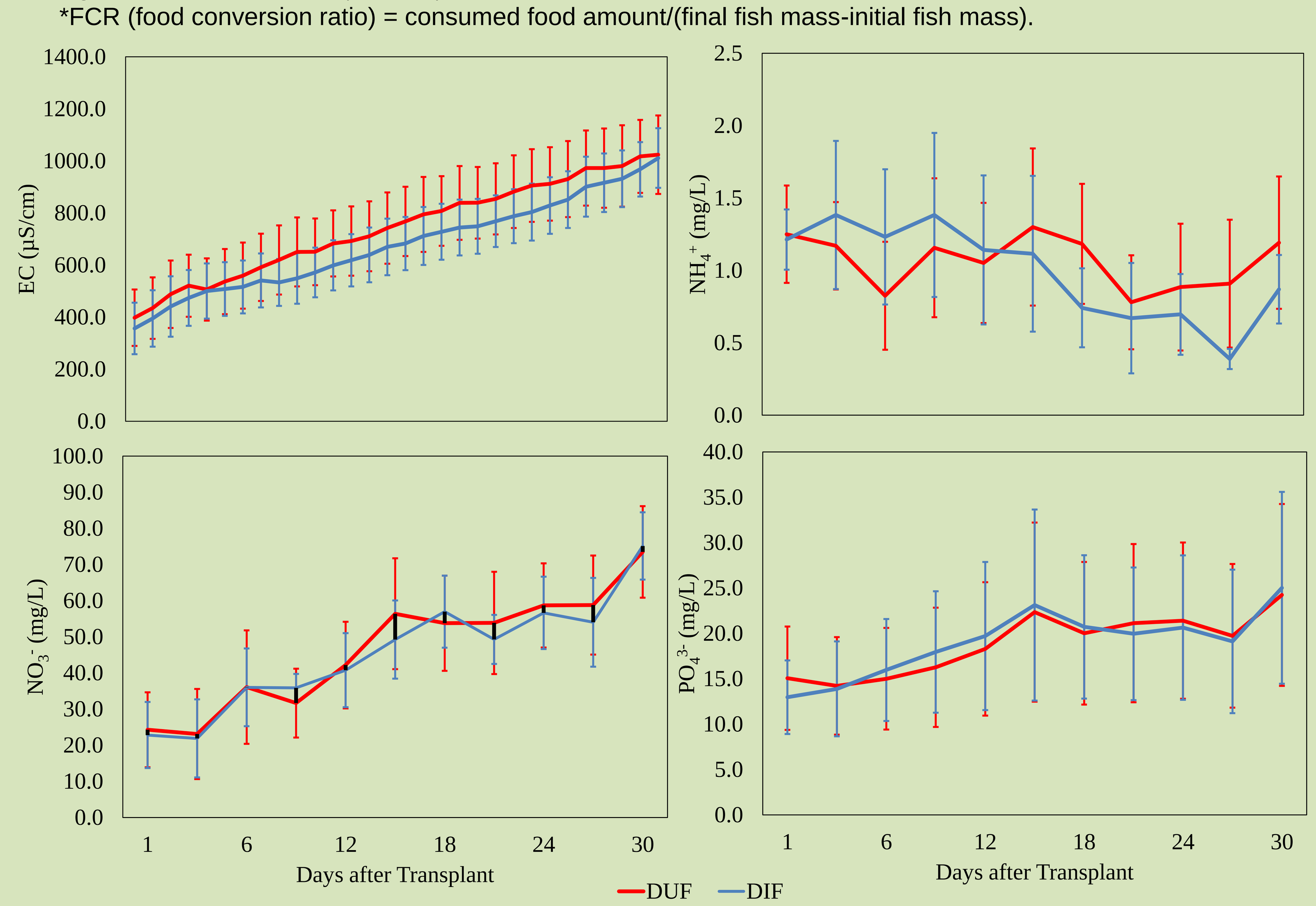

Figure 3. Electrical conductivity (EC), ammonium (NH_4^+), nitrate (NO_3^-), phosphate (PO_4^{3-}) levels in DUF and DIF aquaponics over time.

Results (cont.)

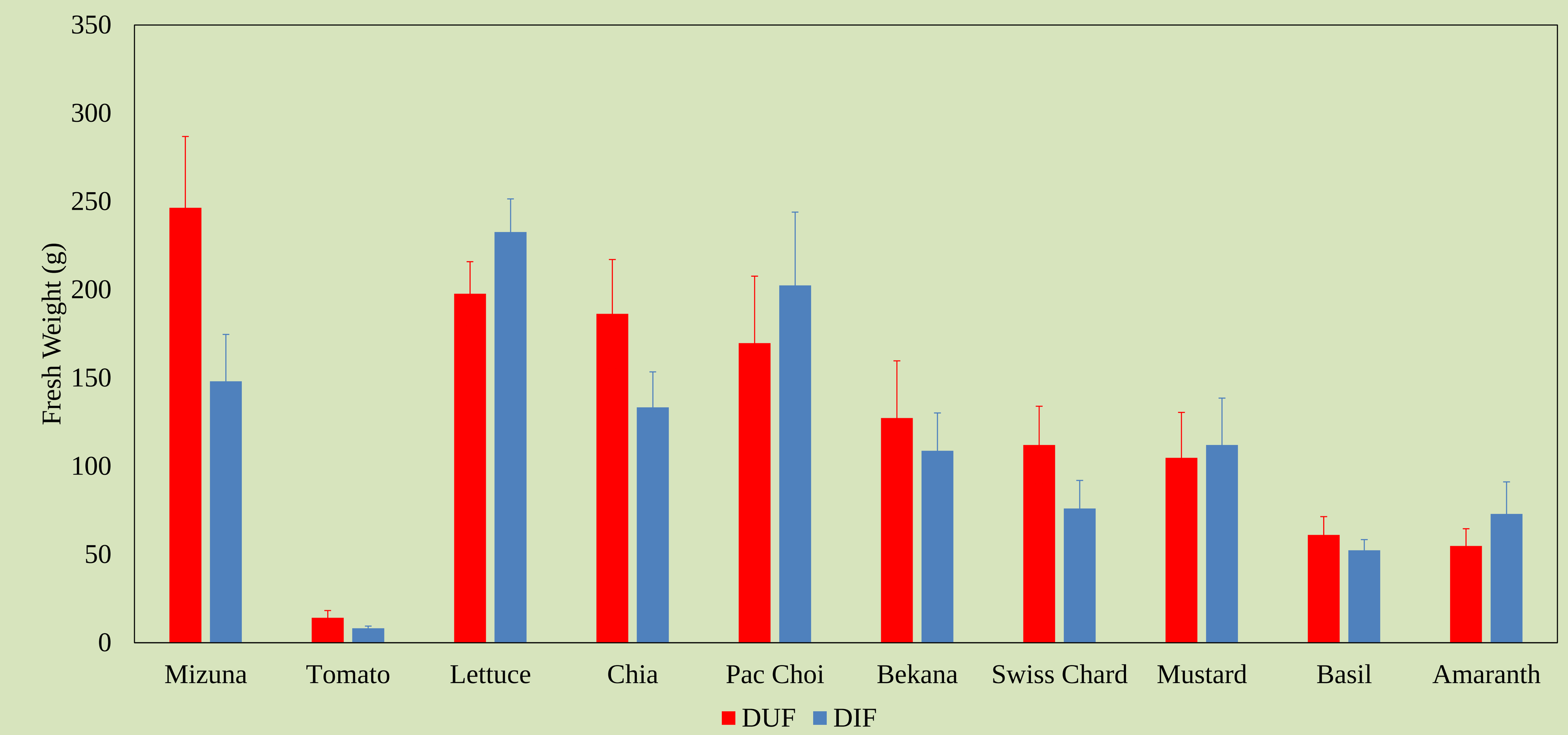

Figure 4. The fresh weight among different crop species in DUF and DIF aquaponics.

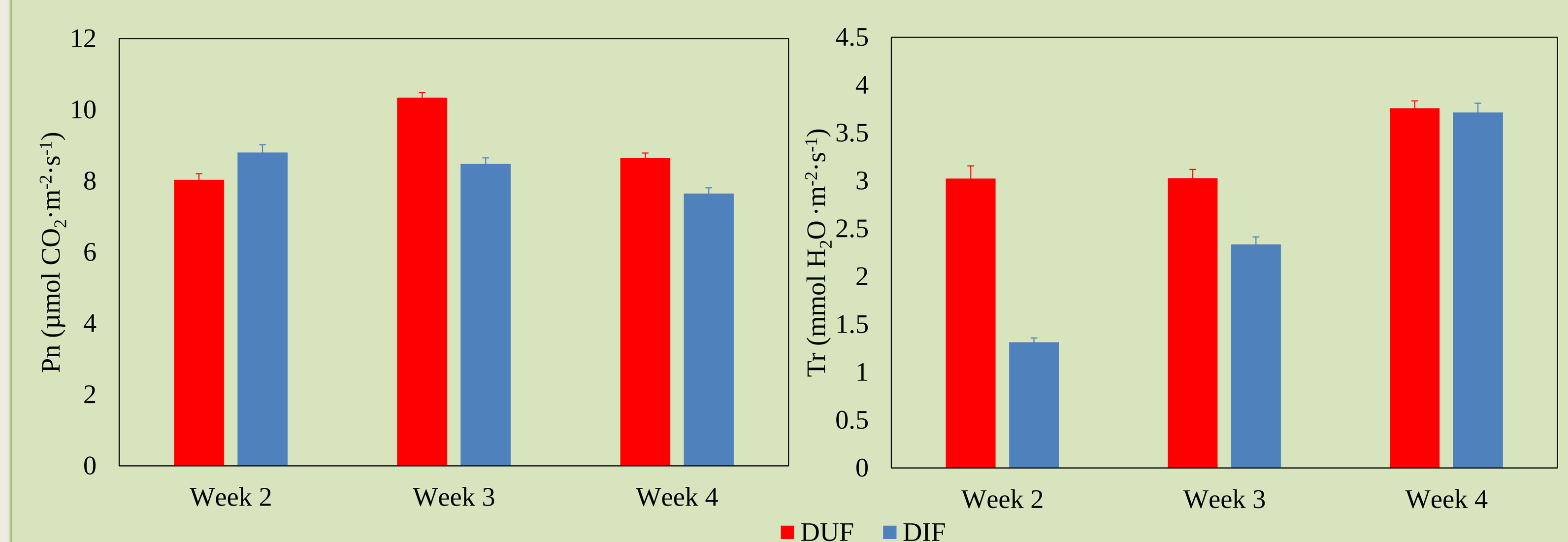

Figure 5. The weekly comparison of photosynthetic rate (Pn) and transpiration rate (Tr) values in DUF and DIF aquaponics.

Conclusions

- The EC increased over time in both systems, but there was no significant difference between the systems. Similarly, NH_4^+, NO_3^-, PO_4^{3-}, pH and DO were not significantly different between the treatments.
- Mizuna in DUF showed higher fresh weight than DIF resulting from significant greater leaf length, number, and area. Similarly, cherry tomato in DUF had a significantly higher fruit fresh weight than DIF.
- Vegetable crops in DUF had a significantly higher Pn and Tr than those in DIF. Data also showed that DUF resulted in a significant lower water consumption than DIF. The feed conversion ratio (FCR) were not significantly different between DUF and, which indicates that DUF may potentially lead to a higher nutrient use efficiency for a long-term production.

In summary, nutrient management practice plays an important role in growth performance of vegetables and fish in aquaponics production and it is critical to optimize the best nutrient management strategy for better performance of an aquaponics system.