

# Effects of Crayfish Aquaponics System on Growth and Yield of Leafy Vegetables



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## Abstract

Aquaponics is an agricultural production system in which the waste produced by aquatic animals, such as fish, provides nutrients for plants. Bacteria in the water convert ammonium from the animal waste into nitrites and then nitrates that plants can use for nourishment. An aquaponics study was conducted at a climate controlled greenhouse at Georgia Southern University, Statesboro, GA, where romaine and green leaf lettuce were used as agricultural crops. Red crayfishes and white river crayfishes were used as the aquatic species. The objectives of the study were to understand and compare the effects of a crayfish aquaponics system and hydroponic (no crayfish) on the growth, vigor and yield of leafy vegetable crops. Six tanks were used to create 12 floating plots of green leaf and romaine combinations. Five of each variety of lettuce were placed on each plot. Randomized complete block design was used to layout the plots. The seedlings were planted in coconut coir and vermiculite and placed in the holes of floating polystyrene sheets, allowing the roots to remain submerged in the water. Each tank housed twelve crayfishes. Crayfish are territorial, so hiding places were provided in the tank to lower the risk of injury and/or mortality in the tanks. The crayfishes were observed throughout the experiment to determine if they can maintain relatively stable populations that will provide enough nutrients for the vegetables. FloraNova Grow (7-4-10) Hydroponic Nutrient Solution was applied to all tanks (355 mL per tank) as a basic nutrient source. The tanks were monitored for water quality to ensure there was a balance between waste production and water/nutrient filtration. It was determined that no significance between aquaponics and hydroponics occurred for chlorophyll index, plant biomass, and plant height. However, romaine lettuce experienced greater chlorophyll index than green leaf. Green leaf lettuce produced higher biomass and length.

## Introduction

Sustainable forms of agriculture and aquaculture are a necessity because the world's population is currently growing at a rate of 1.13% per year. As aquaculture systems have increased due to population demand, so have its environmental impacts. By 2012, aquaculture was predicted to supply over half of the world's seafood.

- Hydroponics is the process of growing plants in a media other than soil, such as liquid or gravel
- Aquaponics is an improved form of hydroponics that uses fish waste to provide nutrients for plants grown hydroponically
- Both are effective systems, but aquaponics is efficient because it utilizes wastewater as a source of nutrients
- Crayfish were chosen to support the crops in this study but many aquatic species can be chosen for aquaponics

Hiding places and proper feeding will keep crayfish from preying upon each other

### Objectives:

- To compare the final biomass between aquaponics and hydroponics systems
- To compare chlorophyll between aquaponics and hydroponics systems
- To measure the pH, ammonia, nitrite, and nitrate levels



Figure 1: Crayfish

## Methodology

- Tanks were placed in a randomized complete block design (RCBD) with 12 plots of romaine and green leaf combinations.
- Each plot contained one variety of lettuce with five individual lettuce plants.
- A SPAD 502 Plus Chlorophyll Meter was used measure chlorophyll content in each of the crops.
- Each tank contained 12 crayfish and was monitored three times a week for population counts.
- Weekly water tests were conducted to monitor pH, ammonia, nitrate, and nitrite levels.



Figure 2: Aquaponics and Hydroponics Study

## Results

**Fresh Weight:** There was no statistical significance observed between the aquaponics and hydroponics systems. However, there was a numerical trend.

**Plant Height:** There was a numerical trend that indicated aquaponics produced lengthier plants than hydroponics. However, there was no statistical significance.

**Chlorophyll Content:** There was no statistical significance observed between the aquaponics and hydroponics systems.

**Lettuce Varieties:** Green leaf fresh weight was significantly higher than romaine. There was a numerical trend for plant height that indicated green leaf was higher than romaine. However, in terms of chlorophyll content, it was reversed.

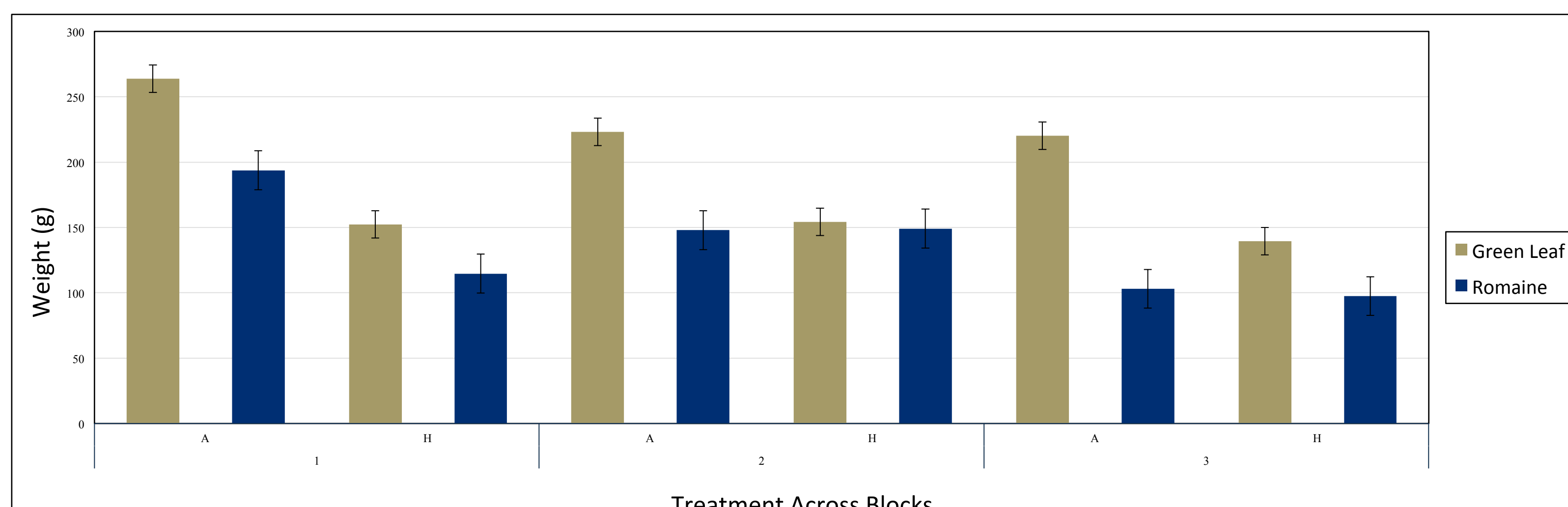


Figure 3: Overall average of plant biomass across in blocks and within aquaponics and hydroponics treatments.

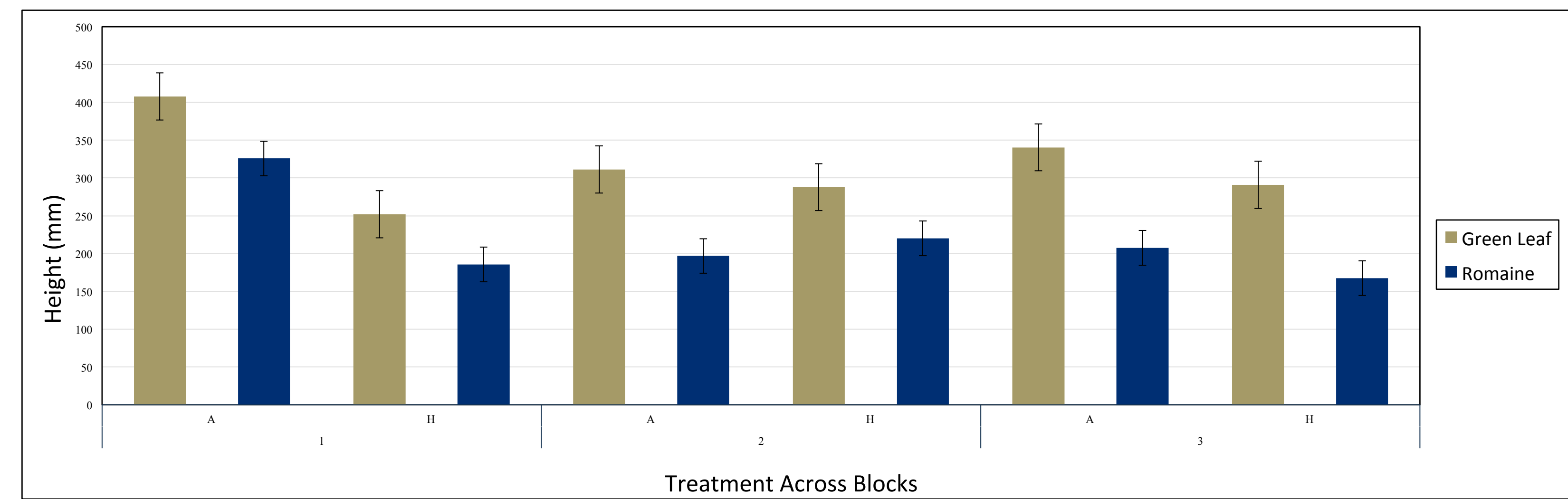


Figure 4: Overall average of plant height across in blocks and within aquaponics and hydroponics treatments.

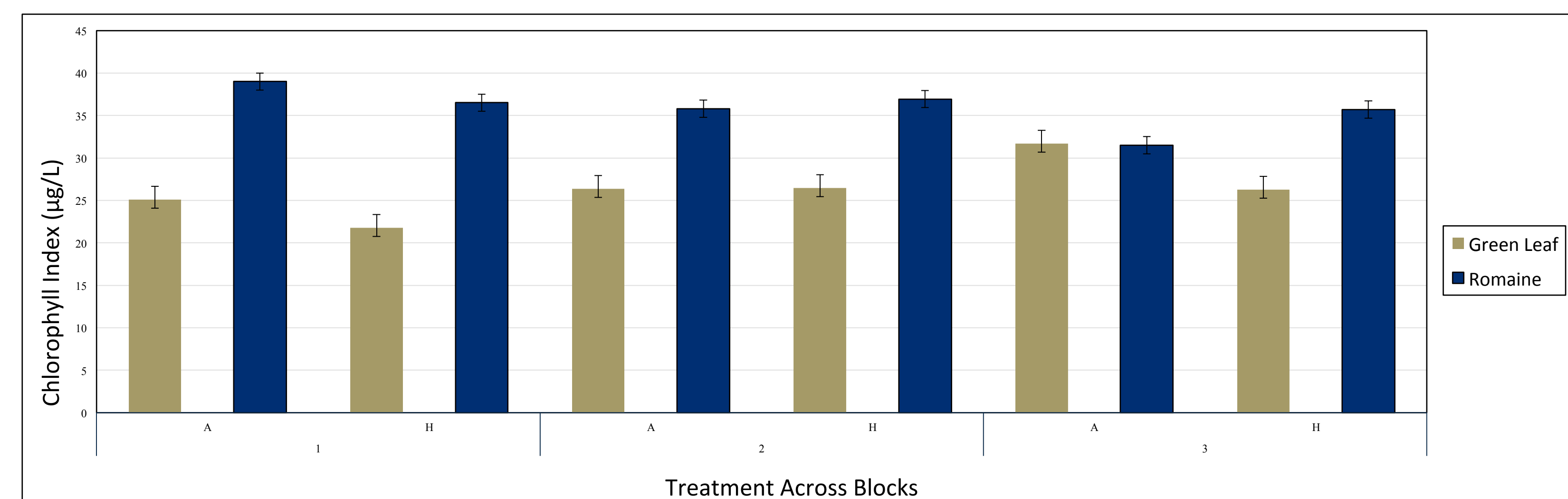


Figure 5: Overall average of chlorophyll index across in blocks and within aquaponics and hydroponics treatments.

Week	Treatment	pH	Ammonia	Nitrite	Nitrate
Week 1 & 2	Aquaponics	8.20	0.21	4.00	6.67
	Hydroponics	8.17	0.00	0.00	0.00
Week 3 & 4	Aquaponics	7.80	6.00	5.00	23.33
	Hydroponics	8.00	8.00	0.21	80.00
Week 5 & 6	Aquaponics	7.40	0.38	3.17	54.17
	Hydroponics	7.47	7.33	5.00	13.33
Week 7 & 8	Aquaponics	6.82	0.25	1.17	45.00
	Hydroponics	6.24	3.00	4.25	10.00
Week 9 & 10	Aquaponics	7.48	0.21	2.5	60.00
	Hydroponics	6.56	2.12	0.00	60.00
Week 11	Aquaponics	7.75	0.12	0.92	80.00
	Hydroponics	6.75	0.33	0.00	80.00

Table 1: Weekly water analysis within aquaponics and hydroponics treatments.

## Discussion

**Fresh Weight:** Crayfishes produced additional nutrients in aquaponics systems, which is why aquaponics plants were greater in biomass than hydroponics.

**Plant Height:** Crayfish nutrient supply allowed more growth in aquaponics tanks.

**Chlorophyll Content:** The health and quality of plants between aquaponics and hydroponics did not differ unlike plant biomass.

**Lettuce Varieties:** Green leaf has a more robust growth due to its loosely gathered. In contrast, romaine had a shorter and more concise leaf growth, which promoted higher chlorophyll content.

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