2016 NCERA-101 Report from Purdue University

1. **New Facilities and Equipment.** A recirculating aquaponics system has been installed in zone 5 of the Horticulture Greenhouse complex at Purdue University. This facility consists of six aquaponics units, each of which is composed of 3 major parts: an aquaculture rearing tank (378 L), a microbial biofilter (20L), and a hydroponic culture tank (378 L). Tilapia have been the fish test species of choice during the first year of operation. Stocking density of 20-25 kg tilapia/m³ has been coupled with stands of vegetable crops including tomato, basil, and leaf lettuce, with the intervening microbial ecosystem including nitrifying bacteria. A research program has been launched to optimize management practices and achieve mass and energy balances under the direction of Dr. Hye-Ji Kim.

2. **Unique Plant Response.** Chinese Cabbage plants grown at Purdue in ground-based mock-ups of the “Veggie” plant-growth units that are growing salad plants on the International Space Station (ISS) developed leaf necrosis as well as chlorosis in addition to growth stunting under ISS environmental conditions.

3. **Accomplishment Summary.** Purdue University mimicked environmental and cultural conditions used on the International Space Station (except for microgravity) to grow Chinese cabbage and dwarf tomato in a growth chamber on the ground using ground-based mock-ups of the ISS “Veggie” plant-growth units. Unlike successful growth responses that have been reported on ISS for leaf lettuce, growth responses of Chinese cabbage and dwarf tomato to ISS and Veggie cultural and environmental conditions have been relatively poor. A number of stress control points have been identified, and effort is underway to eliminate or minimize stressors as well and their potential interactions.

4. **Impact Statement.** To enable a “pick-and-eat” salad-growth scenario for the crew of the International space Station, NASA has established on ISS a Veggie Plant-Growth Unit that is lighted by LEDs. In addition to the microgravity environment of ISS, plants grow under the ambient temperature (24.5 C days / 21 C nights), humidity (45% days / 55% nights), and CO₂ (2800 ppm average) environment of the ISS crew cabin. Initial trials involving a given cultivar of leaf lettuce grown on ISS resulted in normal plant growth compared to ground-based conditions. Trials of a promising cultivar of Chinese cabbage at Purdue varying combinations of growth-substrate composition, incorporated timed-release fertilizers, LED spectral composition, and total light intensity conducted in a growth chamber using Biomass-Production-Systems-for-Education (BPSe) units under ISS environmental conditions resulted in vastly inferior plant growth compared to greenhouse controls. Similar poor growth was found for a promising dwarf tomato cultivar under ISS conditions. Although multiple cultural and / or environmental stressor combinations...
are suspected to be causal, attempts to eliminate them one by one have failed to improve growth of Chinese cabbage, until CO₂ was reduced from 2800 PPM to near Earth-normal ambient. Since modification of ambient crew-cabin CO₂ concentration is not an option for plant growth in Veggie on ISS, investigations are underway at Purdue to alleviate other-CO₂ environmental / cultural stressors in effort to determine if eliminating those interactions can significantly reduce plant response to supra-optimal CO₂. Parallel efforts are investigating whether genetics and / or genetics x environment interactions are responsible for the negative response of the Chinese cabbage cultivar thus far tested to supraoptimal CO₂ in combination with other ISS plant-growth conditions.

**Published Written Works.**

**Book Chapters:**


**Refereed Journal Articles:**

Dzakovich, M., C. Gomez, and C. Mitchell. 2015. Tomatoes grown with light-emitting diodes (LEDs) or high-pressure sodium (HPS) vs. HPS supplemental lighting are of comparable quality. HortScience 50 (10): 1-5.

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