Diamond Mangrum

NASA's Kennedy Space Center

New Crop Selection experiment (1500ppm vs. 650ppm)

ABSTRACT

The mission of the National Aeronautics and Space Administration is to reach for new heights for the benefit of humankind. In order for space flight to be feasible over further distances and longer durations of time, food must be sustainably produced under the unique conditions of space. Freeze drying, the method commonly used by astronauts for food supply, is not suitable for prolonged space flight because the food loses its nutritional value as time passes. Kennedy Space Center's Utilization and Life Sciences Office (UB-A), under the Exploration Research and Technology Program (UB), conducts research on plant growth and development under International Space Station (ISS) conditions. The New Crop Selection experiments are testing the suitability of leafy crops to ISS conditions. Through this particular experiment, we seek to optimize food production by analyzing the growth responses of leafy greens through the manipulation of CO_2 levels.

The two unique carbon dioxide levels the plant study will compare are 1500 ppm and 650 ppm. Our controlled variables include a 23 temperature, a fifty percent relative humidity level, and four Heliospectra RX30 light fixtures in each of the six by eight feet walk-in chambers. Each plant species was grown in 4-inch square plastic pots containing 70% Fafard B potting mix, and 30% arcillite (Turface Pro League or MVP 1.0 - 2.4 mm average size). Twelve of each species was planted in each chamber. These species included 'Amara Mustard' (*Brassica*

carinata), Red Russian Kale (*Brassica napus pubularia*), 'Toscano' Kale (*Brassica oleracea*), 'Dragoon' Lettuce (*Lactuca sativa*), 'Outredgeous' Lettuce (Lactuca sativa), Barase Swiss Chard (*Beta vulgaris*), 'Extra Dwarf' Pak Choi (Bok Choi) (Brassica rapa subsp. chinensis), and Shungiku (*Glebionis coronaria*).

Three seeds of each species was planted in each of twelve pots. Four species were on the left tray, facing the door of the chamber, and the other four species were on the right tray. Watering stakes, with drippers connecting to a watering delivering manifold, were then placed in each potting mix filled pot. The watering was programmed to emit water two times a day, 9:00 and 18:00, for one minute each time. As needed watering frequencies were altered and zip ties were used to tie down watering stakes.

All pots were covered with clear, plastic wrap to maintain a high relative humidity (RH) for germination. Depending on the species, as germination occurs, plastic wrap was removed from the species and the species were watered with deionized water within the first three to five days. On day seven after planting, the seedlings were thinned to one seed per pot, with preference given to most developed seedling. Some of the thinned plants were transplanted to unused pots for informal comparisons.

Harvest of three plants from each species took place fourteen days after planting and twenty-one days after planting. At twenty-eight days after planting, for the final harvest, every plant is harvested. At the time of harvest, the plants are photographed, measured for height and widths, weighed for their fresh weight, and weighed for their dry weight. The remaining plants were also respaced at this time inside the chamber.

The results of the harvest showed there was a higher fresh mass average for plants that came from Chamber D. This could indicate a proportional relationship between carbon dioxide levels and fresh mass average because Chamber D was kept at a carbon dioxide level of 1500 ppm which is more than double the amount of carbon dioxide that was being maintained in Chamber C. For shoot height averages, the data was more ambiguous. The plant species in 1500 ppm of carbon dioxide outperformed the species housed in 650 ppm for four out of the eight plants. However, the difference in shoot height was only statistically greater for Pak Choi which showed an 11.1 mm greater height, produced by Chamber C, than Chamber D *(See Table 1)*. However, evident by the standard error, the results were not as drastic as it seems considering there was so much variation within the readings *(See Figure 1)*. Final results are forthcoming as experiment is still in progress.

Table 1: Fresh Mass Averages, Shoot Height Averages, Shoot Area Averages, and Dry Mass Averages for each crop

Chamber C (650 ppm) 14 DAP				
	Fresh Mass Average	Shoot Height Average	Shoot Area Averages	Dry Mass Average
Dragoon Lettuce	0.87	4.00	2116.50	0.06
Pak Choi	2.43	29.3	7575	0.15
Outredgeous Lettuce	1.1	5.33	2762.42	0.09
Shungiku	0.97	12.33	3380.021	0.06

Barese Swiss Chard	1.57	20.7	3715.8	0.09
Red Russian Kale	2.4	16.33	10500.3	0.2
Toscano Kale	1	11	5338.96	0.1
Amara Mustard	2.7	11.5	7256.25	0.24

Chamber D (1500 ppm)				
	Fresh Mass Average	Shoot Height Average	Shoot Area Averages	Dry Mass Average
Dragoon Lettuce	1.43	3.33	2461.16	0.11
Pak Choi	4.63	18	3756.83	0.33
Outredgeous Lettuce	1.9	4	5536.85	0.14
Shungiku	1.13	8.67	5287.9389	0.09

Barese Swiss Chard	1.9	18	4601.56	0.11
Red Russian Kale	3.13	18.67	13306.33 89	0.28
Toscano Kale	1.47	17.67	6249.228 9	0.15
Amara Mustard	4.1	14	9668.721 1	0.35

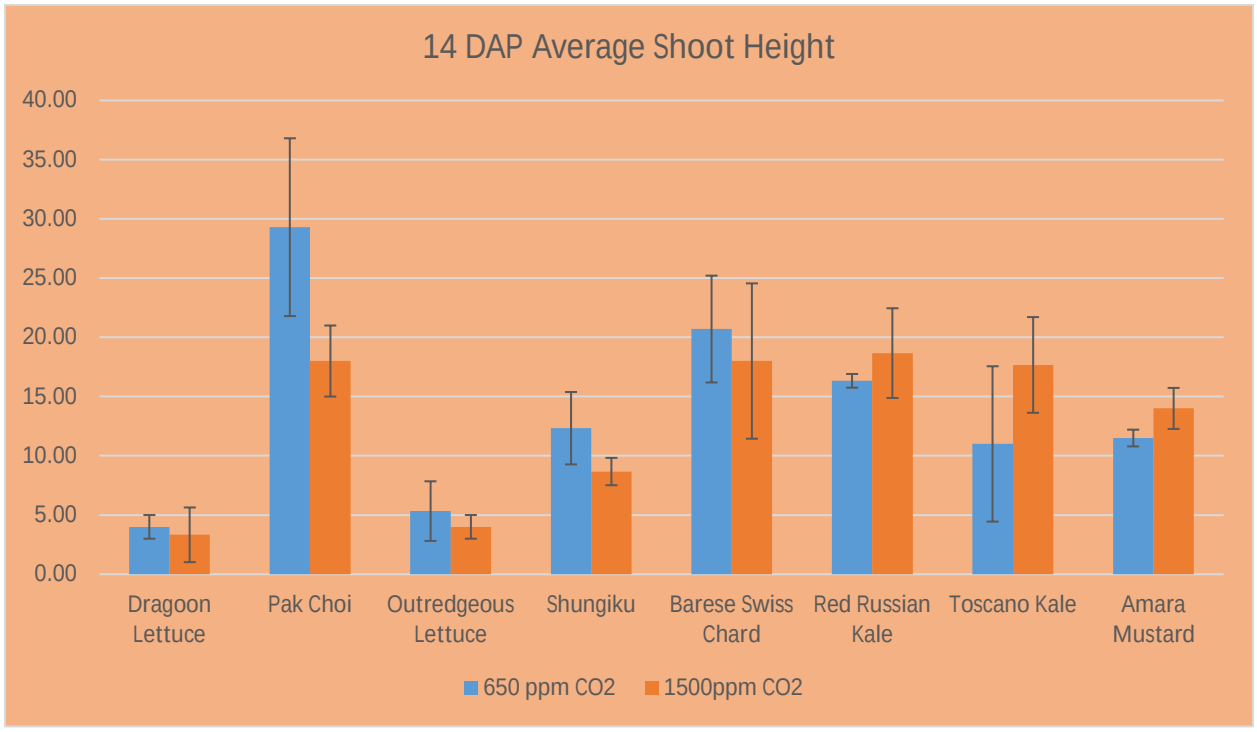

Figure 1: Average Shoot Height 14 DAP

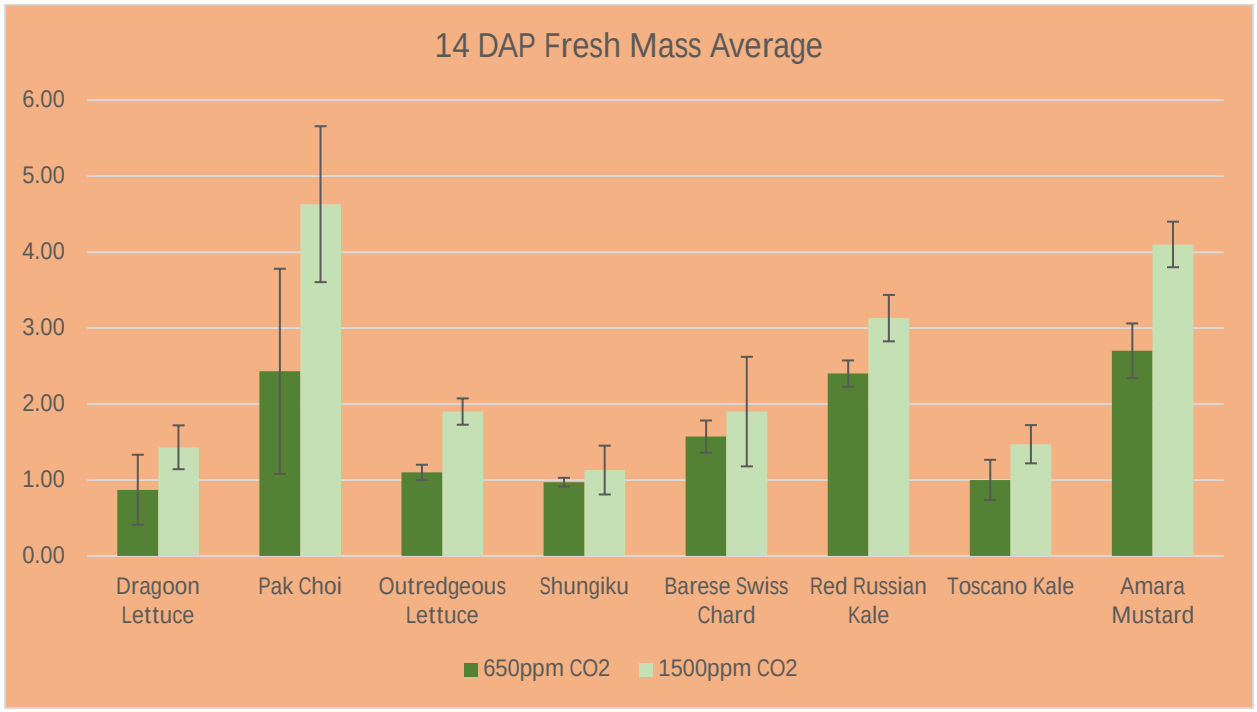

Figure 2: Fresh Mass Average 14 DAP