Evaluating rank order of microgreen cultivars for biomass and water soluble carbohydrate concentrations across diverse environments

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Introduction

Microgreens have been used commercially as early as the 1980s and are increasing in popularity among innovative restaurants and health conscious consumers (Bliss, 2014; Kaiser and Ernst, 2012). Microgreen classification is based on plantlet size and maturity. Microgreens are usually immature plants 2-7 cm in height, typically harvested after 7 to 14 d depending on species. They are sold or consumed with the stem and fully developed cotyledon leaves attached (Xiao et al., 2012). Microgreens are commonly grown in greenhouses or controlled environments, with or without artificial lights, to protect the sensitive young plants from harsh environmental conditions (Di Gioia et al., 2017; Murphy et al., 2010). They are nutrient-dense vegetables with a host of bioactive compounds and usually have higher levels of phytonutrients as compared to their mature forms (Vaštakaitė and Viršilė, 2016; Xiao et al., 2012). Brassicas, lettuces, and herbal crops are the most commonly grown microgreens due to their fast germination and production time and simple cultivation needs. Concentrations of water soluble carbohydrates in microgreens will contribute to flavor attributes.

The objective of this study was to screen fifteen commercially grown microgreen cultivars in cool, low light and warm, high light environments for germination timing, fresh mass (FM) accumulation, and water soluble carbohydrate concentrations.

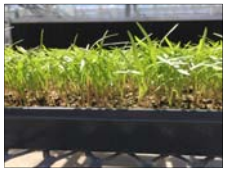
Materials & Methods

Plant Culture and Carbohydrate Determination

Five cultivars each of lettuce, herb, and brassica crops were grown under greenhouse conditions using a soilless peat mix in solid-bottom plastic trays (26 x 52 x 3 cm) and misted daily using a fine spray nozzle head. All aboveground microgreen FM was harvested after plantlets reached the first to second true leave stage. Samples were freeze-dried and measured for concentrations of water soluble carbohydrates using HPLC methodology. Production was compared between two distinct environments, a **cool, low light** production period and a **warm, high light** production period (see conditions below). Data were analyzed using Spearman's rank order correlation to determine the monotonic relationship of cultivars across the two environmental growing conditions.

Greenhouse Environmental Conditions		
	Cool, low light	Warm, high light
PAR (umols·m^{-2}·s^{-1})	161	467
DLI (mols·d^{-1})	14	40
Air temp (°C)	20	25

Brassica
Champion Collards
Hong Vt Radish
Kogane Chinese Cabbage
Red Cabbage
Red Giant Mustard
Herb
Calypso Cilantro
Genovese Basil
Giant of Italy Parsley
Grosfruchtiger Fennel
Italian Large Leaf Basil
Lettuce
Buttercrunch
Carioca
Red Sails
Vulcan
Winter Density



Spearman's rank order correlation to determine the monotonic relationship among microgreen cultivars grown under two environmental conditions

Rank Order for Fresh Mass of Shoot Tissue			
Cool, low light	Cultivar	Warm, high light	Cultivar
1	Hong Vit Radish	1	Hong Vit Radish
2	Red Cabbage	2	Carloca Lettuce
3	Red Sails Lettuce	3	Red Cabbage
4	Kogane Chinese Cabbage	4	Red Sails Lettuce
5	Vulcan Lettuce	5	Kogane Chinese Cabbage
6	Champion Collards	6	Buttercrunch Lettuce
7	Carloca Lettuce	7	Red Giant Mustard
8	Italian Large Leaf Basil	8	Champion Collards
9	Buttercrunch Lettuce	9	Italian Large Leaf Basil
10	Red Giant Mustard	10	Genovese Basil
11	Grosfruchtiger Fennel	11	Vulcan Lettuce
12	Genovese Basil	12	Grosfruchtiger Fennel
13	Calypso Cilantro	13	Winter Density Lettuce
14	Winter Density Lettuce	14	Calypso Cilantro
15	Giant of Italy Parsley	15	Giant of Italy Parsley

Rank Order for Glucose in Shoot Tissue			
Cool, low light	Cultivar	Warm, high light	Cultivar
1	Red Giant Mustard	1	Hong Vit Radish
2	Hong Vit Radish	2	Red Giant Mustard
3	Calypso Cilantro	3	Kogane Chinese Cabbage
4	Champion Collards	4	Grosfruchtiger Fennel
5	Kogane Chinese Cabbage	5	Champion Collards
6	Carloca Lettuce	6	Calypso Cilantro
7	Grosfruchtiger Fennel	7	Carloca Lettuce
8	Giant of Italy Parsley	8	Red Sails Lettuce
9	Buttercrunch Lettuce	9	Giant of Italy Parsley
10	Red Sails Lettuce	10	Red Cabbage
11	Red Cabbage	11	Buttercrunch Lettuce
12	Vulcan Lettuce	12	Italian Large Leaf Basil
13	Winter Density Lettuce	13	Winter Density Lettuce
14	Italian Large Leaf Basil	14	Genovese Basil
15	Genovese Basil	15	Vulcan Lettuce

Rank Order for Sucrose in Shoot Tissue			
Cool, low light	Cultivar	Warm, high light	Cultivar
1	Giant of Italy Parsley	1	Carloca Lettuce
2	Vulcan Lettuce	2	Buttercrunch Lettuce
3	Carloca Lettuce	3	Red Sails Lettuce
4	Buttercrunch Lettuce	4	Winter Density Lettuce
5	Red Sails Lettuce	5	Calypso Cilantro
6	Winter Density Lettuce	6	Kogane Chinese Cabbage
7	Hong Vit Radish	7	Red Giant Mustard
8	Kogane Chinese Cabbage	8	Vulcan Lettuce
9	Calypso Cilantro	9	Giant of Italy Parsley
10	Red Giant Mustard	10	Grosfruchtiger Fennel
11	Grosfruchtiger Fennel	11	Italian Large Leaf Basil
12	Italian Large Leaf Basil	12	Hong Vit Radish
13	Champion Collards	13	Red Cabbage
14	Red Cabbage	14	Champion Collards
15	Genovese Basil	15	Genovese Basil

Rank Order for Fructose in Shoot Tissue			
Cool, low light	Cultivar	Warm high light	Cultivar
1	Calypso Cilantro	1	Hong Vit Radish
2	Carloca Lettuce	2	Red Sails Lettuce
3	Red Sails Lettuce	3	Carloca Lettuce
4	Vulcan Lettuce	4	Grosfruchtiger Fennel
5	Hong Vit Radish	5	Calypso Cilantro
6	Buttercrunch Lettuce	6	Buttercrunch Lettuce
7	Grosfruchtiger Fennel	7	Kogane Chinese Cabbage
8	Champion Collards	8	Giant of Italy Parsley
9	Red Giant Mustard	9	Red Giant Mustard
10	Winter Density Lettuce	10	Vulcan Lettuce
11	Kogane Chinese Cabbage	11	Champion Collards
12	Red Cabbage	12	Winter Density Lettuce
13	Giant of Italy Parsley	13	Red Cabbage
14	Italian Large Leaf Basil	14	Genovese Basil
15	Genovese Basil	15	Italian Large Leaf Basil

Results & Conclusions

Rank order correlation for days to germination was r_s=0.771 ($P \leq 0.001$). Cultivars averaged 5.8 days to germination in the cool, low light environment and 4.5 days in the warm, high light environment. Rank order correlation for FM was r_s=0.832 ($P \leq 0.001$). Fresh mass of cultivars averaged 92.8 g per flat in the cool, low light environment and 97.3 g per flat in the warm, high light environment. Rank order correlation for tissue sucrose (r_s=0.712; $P \leq 0.001$), fructose (r_s=0.757; $P \leq 0.001$), and glucose (r_s=0.911; $P \leq 0.001$) were also significant. Tissue sucrose averaged 13.8 mg·g^{-1} dry mass (DM) in the cool, low light environment and 7.21 mg·g^{-1} DM in the warm, high light environment; tissue fructose averaged 13.38 mg·g^{-1} DM in the cool, low light environment and 15.36 mg·g^{-1} DM in the warm, high light environment; and tissue glucose averaged 14.11 mg·g^{-1} DM in the cool, low light environment and 17.31 mg·g^{-1} DM in the warm, high light environment. Cultivar rankings for germination timing, FM production, and water soluble sucrose, fructose, and glucose remained stable over different environments. Stability in cultivar ranking for yield and quality may be useful information for microgreen producers.

Literature Cited

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