NCERA-101 Station Report 2021 – The Ohio State University

Reporting period: April 2020 – October 2021

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1. New Facilities and Equipment (including sensors, instruments, and control systems purchased/installed)

- Construction of Controlled Environment Agriculture Research Complex (CEARC) began in January 2021. This state-of-the-art research greenhouse facility will provide a platform for interdisciplinary research at the nexus of horticulture/crop science, engineering, entomology, plant pathology, food science, computer science, and human nutrition/health. The $36 million project is located at Waterman Agricultural and Natural Resources Laboratory farm and will be completed by summer 2022.
- Old 1000-W MH lamps were replaced with LED lights (GAVITA CT 1930e LEDs, 780 W) in our departmental research greenhouse compartments (a total of 7,000 sqft). While electric power consumption is saved by 20%, the PPFD over bench was increased to 3 times or greater level.
- Soil moisture sensors (Meter EC-5 and TEROS-12) were installed in the strawberry troughs filled with coco-coir substrate.
- UV lights were installed over tomato plants of genotypes sensitive to intumescence-inducing UV-deficient light environment. Operation time and target intensities were selected to provide a minimum UV-B dose (300-320 nm integral: 17 mmol m^{-2} d^{-1}) to prevent intumescence injury.
- LiDAR sensor was installed on a mobile irrigation boom to characterize plant canopy for precision variable rate liquid delivery.

2. Unique Plant Responses

- Low pH 4.0 of hydroponic nutrient solution can effectively suppress the severity of root rot caused by *P. aphanidermatum* initiated by zoospore inoculation without influencing basil plant growth. This could be a new, low-cost strategy for water-borne disease prevention in hydroponic basil production (Gillespie, 2019; Gillespie at al., 2020).
- While basil can tolerate low pH (upto 4.0), most crops exhibit growth reduction caused by reduced nutrient uptake at low pH. When tested at pH 4.5 spinach reduced the shoot fresh weight by almost 60% compared with that under a standard pH 5.5. By increasing the nutrient concentrations (3X), the shoot fresh weight was recovered but still ~25% lower than the standard pH 5.5 (Papio, 2021; Gillespie et al., 2021).
- Nine lettuce cultivars considered as relatively sensitive to tipburn were grown under tipburn inducive conditions to assess the different degrees of sensitivity among cultivar types (romaine, butterhead, and leaf), leaf color (red and green) and production

systems originally targeted in breeding program (open-field and greenhouse). Greenhouse cultivars were found relatively less sensitive and exhibited lower tipburn incidences than did open-field cultivators when grown under tipburn inducive indoor growing conditions. Cultivar-type did not show a significant effect on tipburn sensitivity. (Ertle and Kubota, unpublished)

- Reciprocal grafts between two cultivars – 'Nufar' (NF), a vigorous and Fusarium wilt resistant cultivar, and 'Dolce Fresca' (DF) a compact & uniform type, were evaluated for impact of scion and rootstock on the plant growth and mineral nutrient uptake. While low vigor DF used as rootstock reduced the overall growth of NF, high vigor NF used as rootstock did not increase the overall growth. When NF was used as rootstock, plants developed relatively low biomass in roots suggesting a greater efficiency of nutrient and water uptake for NF. Basil is known to have low mineral nutrient requirement in hydroponics, which may be a reason why improved mineral nutrition did not induce greater vigor or biomass. Therefore, in addition to basil, similar studies were initiated for tomato cultivars and rootstocks in order to better understand underline mechanism of rootstock- or scion-specific mineral nutrition affecting grafting vigor in tomato (Hollick and Kubota, 2021).

3. Accomplishment Summaries

- The Ohio State University founded Ohio Controlled Environment Agriculture Center (OHCEAC) with 18 inaugural faculty members covering Horticulture, Engineering, Plant Pathology, Microbiology, Entomology, Workforce training, and Food Safety.
- The 2021 Greenhouse Management Workshop (January 27-29, 2021) was organized by Peter Ling and Chieri Kubota with 164 participants. This year's focus was 'Improving Production via Listening to Plants'.
- The Strawberry School (March 26, 2021) was organized by Chieri Kubota and Mark Kroggel with 120 participants.

4. Impact Statements

We continue offering an online monthly forum 'Indoor Ag Science Café' to serve as a non-competitive communications platform for indoor farmers and relevant stakeholders. The listserve currently has ~1,000 members, serving as a very effective engagement method with industry stakeholders. During the reporting period, the forums reached a total of 1,373 stakeholders. Cumulative number of views (YouTube) of recorded presentations was 4,167.

5. Published Written Works

Books/Book Chapters

- Zhao, X., **C. Kubota**, and P. Perkins-Veazie (eds.) 2021 Proceedings of II International Symposium on Vegetable Grafting. Acta Horticulturae 1302.

Refereed Journal Articles

- Chowdhury, B.D.B., S. Masoud, Y.J. Son, **C. Kubota,** and R. Tronstad. 2021. A dynamic HMM-based real-time location tracking system utilizing UHF passive RFID. J. Radio

Frequency Identification. Doi: 10.1109/JRFID.2021.3102507

- Gillespie, D.P., G. Papio, and **C. Kubota**. 2021. High nutrient concentrations of hydroponic solution can improve growth and nutrient uptake of spinach (*Spinacia oleracea* L.) grown in acidic nutrient solution. HortScience. 56:687-694.
- Gillespie, D.P., **C. Kubota**, and S. Miller. 2020. Effects of low pH of hydroponic nutrient solution on plant growth, nutrient uptake, and root rot disease incidence of basil (*Ocimum basilicum* L.). HortScience. 55:1251-1258.
- Chowdhury, B.D.B., S. Masoud, Y.J. Son, **C. Kubota,** and R. Tronstad. 2020. A dynamic data driven indoor localization framework based on ultra high frequency passive RFID system. Int. J. Sensor Networks Vol. 34:172–187.
- Teng Yang, Uttara Samarakoon, James Altland, Peter Ling . 2021. Photosynthesis, biomass production, nutritional quality, and flavor-related phytochemical properties of hydroponic-grown arugula under different electrical conductivities. Agronomy 11: (7). 1340.
- Cui, Shaoqing, Lin Cao, Nuris Acosta, Heping Zhu, and Peter P. Ling. 2021. Development of Portable E-Nose System for Fast Diagnosis of Whitefly Infestation in Tomato Plant in Greenhouse. *Chemosensors* 9, no. 11: 297. https://doi.org/10.3390/chemosensors9110297
- Nair, Uchit, Peter Ling, and Heping Zhu. 2021. Improved Canopy Characterization with Laser Scanning Sensor for Greenhouse Spray Applications. Transactions of the ASABE.(in print)

Refereed Conference Proceedings Articles

N/A

Trade Journal Articles

- **Kubota, C**. 2021. Get the inside scoop on why greenhouse strawberries are trending. Greenhouse Growers. https://www.greenhousegrower.com/crops/get-the-inside-scoop-on-why-greenhouse-strawberries-are-trending/

Other Creative Works

- **Kubota, C.** 2021. Tool-based analysis of monthly heating costs for protected cultivation in Ohio. (factsheet). Ohio State University Extension. https://ohioline.osu.edu/factsheet/anr-98
- Raj, A. 2021. Aerial Sensing Platform for Greenhouses. Dept. of Food, Agricultural and Biological Engineering. The Ohio State University, Columbus, OH. MS Thesis.

Website and social media

- Indoor Ag Science Café YouTube Channel: https://www.youtube.com/playlist?list=PLjwIeYlKrzH_uppaf2SwMIg4JyGb7LRXC
- Kubota Lab (Controlled Environment Plant Physiology and Technology): http://u.osu.edu/cepptlab

- Facebook for Controlled Environment Plant Physiology and Technology Lab: https://www.facebook.com/CEPPTLAB/
- CEA Strawberry Information: http://u.osu.edu/indoorberry
- CEA Hydroponics Information: http://u.osu.edu/hydroponics
- Kubota Lab CEA Science Communication blog: http://u.osu.edu/ceatalk