NCERA-101 Station Report 2020 – The Ohio State University

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

- LIDAR based plant sensing systems have been developed for characterizing plant canopy in controlled environments. The sensor mounted on an irrigation boom, and a drone have been used to detect plants and to estimate canopy density.
- A new LED lighting system (Philips GrowWise Control LEDs) was acquired as part of USDA SCRI OptimIA project for leafy greens in indoor farming (www.scri-optimia.org). This system can create custom LED light recipes to optimize the light quality and intensity.

2. Unique Plant Responses

- New pH response charts of nutrient availability specific to liquid culture hydroponic conditions were proposed for spinach and basil plants (fig. 1; Gillespie, 2019), based on nutrient concentrations of the leaf tissue. Compared with charts commonly referenced for soil- or substrate- based conditions, the responses of these charts are species-specific and unique to hydroponic liquid culture conditions. For example, availability of micronutrients that are known to increase in soil and soilless substrates at low pH were shown to decrease in hydroponics under low pH.

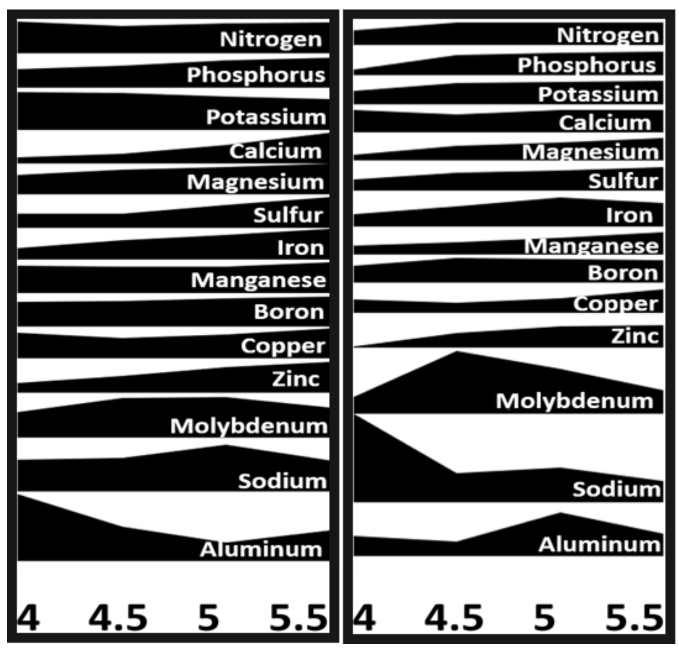

Fig. 1. Nutrient availability based on the leaf nutrient concentrations of basil (left) and spinach (right) plants grown in deep water culture at pH 4.0, 4.5, 5.0 and 5.5 (Gillespie, 2019)

- 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).

- Watermelon seedlings generally exhibit a chilling damage when grown at temperatures lower than 15°C. However, the seedlings could tolerate to a short-term (<48 hours) chilling as low as 3°C (Ertle et al., 2020). The tolerance to 1°C was depending on growing conditions of the young seedlings before the exposure to the chilling (Ertle and Kubota, unpublished).
- Freezing tolerance of watermelon and interspecific hybrid squash rootstock was examined. Watermelon seedlings have lower leaf osmotic potential and some plants (40%) survived at a freezing temperature of -3°C, where interspecific hybrid squash seedlings could not survive. The freezing point of watermelon seedlings was also reduced to below -4°C when plants were acclimatized to a low temperature (10°C) under dim light for 7 days prior to freezing but plants were quickly deacclimatized for one day at an ambient temperature (Maeda and Kubota, unpublished).

3. Accomplishment Summaries

- Precision variable-rate spraying technology has been developed to improve application efficiency for controlled environment plant production in greenhouses. The variable-rate control system reduced spray volume by 29-51% compared with conventional constant-rate spraying.
- The 2020 Greenhouse Management Workshop (January 16-17, 2020) was organized by Peter Ling and Chieri Kubota with 106 participants (including 16 online). This year's focus was 'Sustainable & Safe Crop Production' covering both ornamental and food crops.

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 340 members, serving as a very effective engagement method with industry stakeholders.

5. Published Written Works

Books/Book Chapters

- **Kubota, C.**, M. Chao, S. Masoud, Y.J. Son, R. Tronstad. 2019. Advanced technologies for large-scale plant factories – integration of industrial and systems engineering approach in controlled environment crop production. P.353-362. In: (M. Anpo, H. Fukuda, and T. Wada, eds.) Plant factory using artificial light. Elsevier, Amsterdam, The Netherlands.
- **Kubota, C.** 2019. Understanding crop responses to controlled climates in greenhouses. Chapter 7. (P.205-223) In: (L.F.M. Marcelis and E. Heuvelink eds.) Achieving sustainable greenhouse cultivation. Burleigh Dodds Science, Cambridge, UK.
- **Kubota, C.** 2019. Plant factory business and R&D in the world – current status and perspectives: 3.7 North America (P.69-76) In: T. Kozai, G. Niu, and M. Takagaki (eds.)

Plant factory: An indoor farming system for efficient quality food production. Elsevier, London, UK.

- **Kubota, C.** 2019 Growth, development, transpiration, and translocation as affected by abiotic environmental factors. (P.207-220) In: T. Kozai, G. Niu, and M. Takagaki (eds.) Plant factory: An indoor farming system for efficient quality food production. Elsevier, London, UK.
- **Kubota, C.** 2019 Controlling algae. (P.347-348) In: T. Kozai, G. Niu, and M. Takagaki (eds.) Plant factory: An indoor farming system for efficient quality food production. Elsevier, London, UK.

Refereed Journal Articles

- Cui, S., E. Inocente, N. Acosta, H. Keener, H. Zhu, and **P. Ling**. 2019. Development of Fast E-nose System for Early-Stage Diagnosis of Aphid-Stressed Tomato Plants. *Sensors* 2019, *19*(16), 3480; https://doi.org/10.3390/s19163480
- Lin, Jeng-Liang, Heping Zhu, and **Peter Ling**. 2019. Amendment of herbicide spray solutions with adjuvants to modify droplet spreading and fading characteristics on weeds. Applied Engineering in Agriculture Vol. 35(5): 713-721.
- Yan, Tingting, Heping Zhu, Li Sun, Xiaochan Wang, and **Peter Ling**. 2019. Investigation of an experimental laser sensor-guided spray control system for greenhouse variable-rate applications. Transactions of the ASABE 62(4): 899-911.
- Yan, T., Wang, X., Zhu, H., and **Ling, P**. Evaluation of object surface edge profiles detected with a 2-D laser scanning sensor. Sensors. 18(11): 1-17. 2019.
- Masoud, S., B.D. Chowdhury, Y.J. Son, **C. Kubota**, and R. Tronstad. 2019. Simulation based optimization of resource allocation and facility layout for vegetable grafting operations. Computer and Electronics in Agricutlure. 163:104845.
- Samtani, J.B., C.R. Rom, H. Friedrich, S.A. Fennimore, C.E. Finn, A. Petran, R.W. Wallace, M.P. Pritts, G. Fernandez, C.A. Chase, **C. Kubota**, and B. Bergefurd. 2019. The status and future of the strawberry industry in the United States. HortTechnology https://doi.org/10.21273/HORTTECH04135-18

Refereed Conference Proceedings Articles

- **Kubota, C**. 2020. A simple theoretical comparison of production costs between greenhouses and indoor farms: A case analysis in Ohio. Acta Horticulturae (Accepted)
- McKean, T., M. Kroggel, **C. Kubota** and R. Naasz. 2020. Evaluation of four soilless substrate systems for greenhouse strawberry production. Acta Horticulturae (Accepted)
- Ertle, J., **C. Kubota**, and E. Pliakoni. 2020. Transplant quality and growth of grafted and non-grafted watermelon seedlings as affected by chilling during simulated long-distance transportation. Acta Horticulturae (Accepted)

Trade Journal Articles

- Wicks, Mary and Peter Ling. 2019. Sustainable and Safe Greenhouse Crop Production. Ohio Country Journal, Mid-December issue. October issue.

- Ling, Peter and Mary Wicks. 2019. Space Age Crop Production on Planet Earth. Ohio Country Journal, Mid-December issue.

Other Creative Works

N/A

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
- Kubota Lab CEA Science Communication blog: http://u.osu.edu/ceatalk