Proc. Fla. State Hort. Soc. 134:148. 2021.

—Scientific Note—

Lettuce Cultivated in Hydroponics Responds to Less Phosphorus Inputs

Gustavo F. Kreutz, Jehangir Bhadha, and Germán V. Sandoya*

Everglades Research and Education Center, University of Florida, IFAS, Belle Glade, FL

Additional index words. breeding, hydroponic production, lettuce yield, phosphorus use efficiency

Lettuce (*Lactuca sativa* L.) is the most widely consumed leafy vegetable worldwide. In recent years, hydroponics lettuce production has increased in Florida. Despite the lower pest, disease and weed pressure, and the reduction of water and nutrient requirements, the increasing prices of fertilizers, including phosphorus (P), present a major hurdle for hydroponic lettuce production. Identifying lettuce genotypes capable of producing high yields with low P inputs may help reduce fertilizer use, production costs, and excess P in wastewater. The objective of this study was to identify lettuce genotypes that use P more efficiently in a hydroponic system.

Two greenhouse experiments were conducted at the University of Florida/IFAS Everglades Research and Education Center in Belle Glade, FL. In each experiment, 12 lettuce genotypes: romaine (6); crisphead (5); and bibb (1) types were grown in two nutrient film technique (NFT) systems. Each system contained a modified Howard Resh solution plus one P treatment: either low P (3.1 ppm) or high P (31 ppm). Phosphorus was supplied in the form of phosphoric acid (H_3PO_4) with all other macro and micronutrients kept constant. Solutions were replaced every 14 days to avoid nutrient imbalance. Electrical conductivity and pH of solutions were adjusted to ranges of 1.4 to 1.8 mS/cm and 6.0 and 6.5, respectively. The genotypes were replicated three times in each NFT system, with each replicate consisting of a single plant. Seedlings were started in rockwool cubes and transplanted into the NFT 11 days after sowing. Plants were harvested at horticultural maturity to measure fresh weight [FW (g)] of shoots and roots and tipburn incidence. After, shoot and root tissues were oven-dried at 65 °C for 7 days to obtain dry weight [DW (g)], then the root-shoot DW ratio was calculated. Tissue total-P concentration [TTP ($mg \cdot g^{-1}$)]was measured in Experiment 1 only, following a hydrochloric acid extraction and analysis using an inductively coupled plasma optical emission spectrometer (ICP-OES). Phosphorus uptake efficiency [PUpE (mg P $mg \cdot L^{-1}$ P applied)] and P utilization efficiency [PUtE ($g \cdot mg^{-1}$ P DW)] were calculated for each genotype according to the formulae:

$$PUpE = \frac{TTP * DW}{Phosphorus\ applied\ (mg \cdot L^{-1})}$$

$$PUtE = \frac{DW}{DW * TTP}$$

Data were analyzed using SAS® software, Version 9.4 (SAS Institute Inc., Cary, NC, USA).

Yields of 'Little Gem', 60183, 'Valmaine', 'Green Lightning', and BG19-0539 were statistically similar ($P > 0.05$) for FW with low and high P. The root-shoot DW ratio of most genotypes, except for 'Little Gem' and 'Honcho II', increased at low P vs. high P, suggesting that lettuce responds to P-limited conditions by modifying its root morphology, as previously noted in lettuce transplants under a floatation irrigation system (Soundy et al., 2001). At low P, 'Manatee' and 'Valmaine' had the highest tissue P content and P uptake (PUpE) among all genotypes. In contrast, 'Okeechobee' and 'Sun Devil' had the lowest tissue P content and the highest P utilization (PUtE) at low P. Lettuce accessions may use P differently due to differences in P-starvation responses associated with plant morphology and physiology (Fageria et al., 2017). Tipburn incidence was significantly higher ($P = 0.0253$) at low P than at high P. No tipburn was detected in 'Green Lightning', 'H1078', and 'Sun Devil', whereas 'Little Gem' had the highest tipburn incidence in both P treatments. Other genotypes had only minor symptoms at low and/or high P. Tipburn incidence in hydroponic lettuce was found to be influenced by cultivar and availability of nutrients, such as calcium (Leskovar et al., 2016). Perhaps the lack of adequate P has a negative influence in tipburn development. Results from this research indicate the presence of genetic variation for FW, tipburn, PUpE, and PUtE among hydroponically grown lettuce genotypes. Preliminary results from this research can contribute to breeding programs that aim to develop P (or any other nutrient) efficient lettuce cultivars for hydroponic production. Further investigations are needed to determine the specific mechanisms of PUpE and PUtE in hydroponic lettuce.

Literature Cited

Fageria, N.K., Z. He, and V.C. Baligar. 2017. Phosphorus management in crop production. CRC Press, Boca Raton, FL.

Leskovar, D.I., V. Cerven, and Y. Othman. 2016. Cultivar and calcium management to minimize lettuce tipburn in greenhouse hydroponics. HortScience 51(9):352 (abstr.).

Soundy, P., D.J. Cantliffe, G.J. Hochmuth, and P.J. Stoffella. 2001. Nutrient requirements for lettuce transplants using a floatation irrigation system. I. Phosphorus. HortScience 36(6):1066–1070. https://doi.org/10.21273/HORTSCI.36.6.1066

*Corresponding author. Email: gsandoyamiranda@ufl.edu