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Introduction

Field production of vegetable crops in the southwest Texas region is limited by strict regulations of water use for irrigation, and by adverse environmental conditions such as drought and heat stress (Leskovar et al., 2014). Therefore, the vegetable industry is increasingly interested in maximizing water use efficiency (WUE) when growing high-value, leafy vegetables. The Nutrient Film Technique (NFT) culture system makes efficient use of water, and is suitable for vegetables grown in controlled environment agriculture (greenhouses, high tunnels). The objective of this study was to evaluate WUE, growth and quality of Bibb, Loose-leaf and Romaine lettuce types over three production cycles in a recirculating hydroponic system.

Materials and Methods

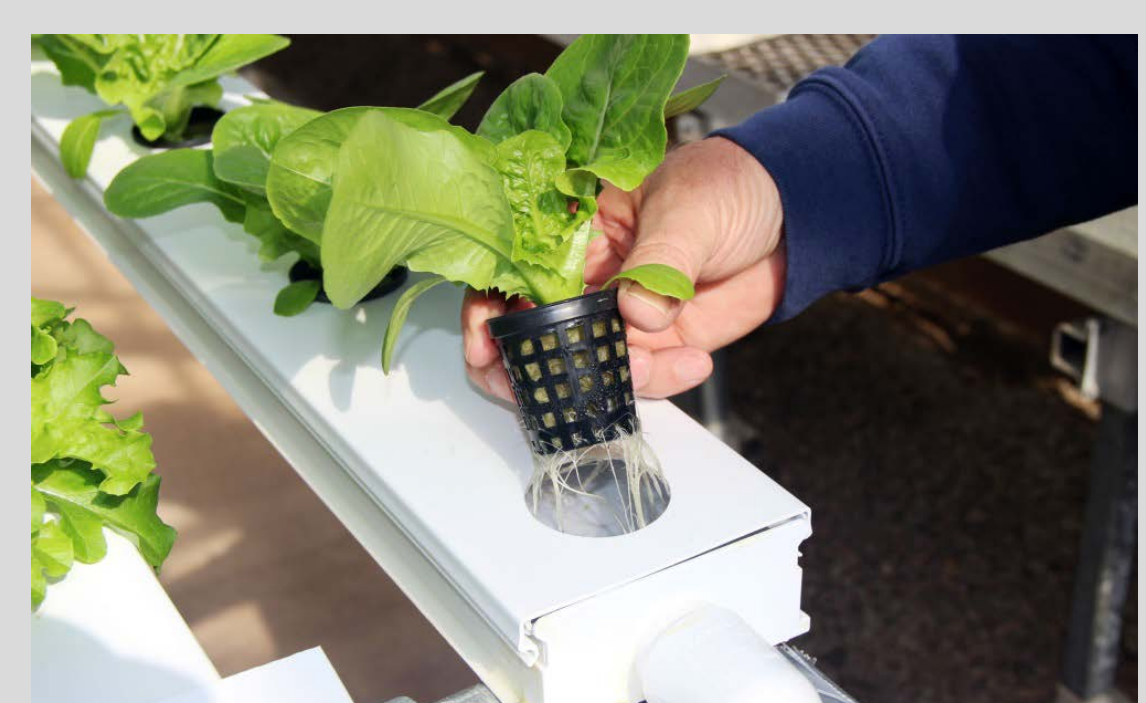
- Lettuce (*Lactuca sativa* L.) cultivars chosen were:
 - Bibb type: Buttercrunch, Bibb.
 - Loose-leaf type: Ezatrix, Caipira, Kremlin Red Leaf, Progreen 76, Ezfrill, Ezfilan, Pearl Gem.
 - Romaine type: Sunbelt, Chabi.
- Seedlings were grown in 98 cell rockwool slabs in trays in greenhouse conditions.
- Three weeks after seeding, transplants were placed 20 cm apart into the recirculating hydroponic NFT channels.
- Nutrient solution contained: Total N 200, N-NH₄ 9.3, N-NO₃ 190.6, P₂O₅ 133, Ca 186.6, Mg 33.3, S 73.3, Mn 3.3, Mo 0.033 (mg.L⁻¹)
- Crops were harvested in 3 cycles in December 2014, February 2015 and March 2015.
- Measurement taken were: Leaf fresh and dry weight, leaf number and length, stem diameter, sugar (Brix) and chlorophyll content (SPAD); water use efficiency (L.g⁻¹ DW).



Seedling growth



Transplanting



Early development



Before harvest



Results

| Cultivar | Cycle 1 | | Cycle 2 | | Cycle 3 | |
|------------------------|---------|-------|---------|-------|---------|-------|
| | LFW | LDW | LFW | LDW | LFW | LDW |
| Bibb type | | | | | | |
| Bibb | 70.5a | 2.9a | 176.4b | 3.1b | 211.7b | 5.9a |
| Buttercrunch | 144.6a | 5.9a | 301.4a | 5.9a | 273.7a | 8.9a |
| LSD (.05) | 75.7 | 3.1 | 97.2 | 1.1 | 59.5 | 3.9 |
| Loose-leaf type | | | | | | |
| Bellatrix | 59.2cb | 2.6cb | 84.7d | 1.6d | 91.8fe | 3.3ed |
| Ezatrix | 121.9a | 4.7a | 186.4b | 3.6bc | 200.7cb | 6.3b |
| Caipira | 89.7b | 3.5b | 185.9b | 3.4c | 175.5cd | 5.3c |
| Kremlin Red Leaf | 76.8cb | 3.5b | 163.7b | 3.8bc | 159.7d | 5.8cb |
| Progreen 76 | 76.1cb | 2.8cb | 182.5b | 4.3ba | 208.9b | 8.3a |
| Ezfrill | 61.8cb | 2.5cb | 125.3c | 2.4d | 121.1e | 4.0d |
| Ezfilan | 56.4c | 2.3c | 81.0d | 1.8d | 84.1f | 3.1e |
| Pearl Gem | 65.3cb | 2.9cb | 240.7a | 4.7a | 245.8a | 8.1a |
| LSD (.05) | 32.1 | 1.1 | 28.5 | 0.7 | 29.5 | 0.9 |
| Romaine type | | | | | | |
| Sunbelt | 120.8a | 4.7a | 255.3a | 4.9a | 256.6a | 8.7a |
| Chabi | 94.5b | 4.2a | 202.1b | 3.8b | 233.4a | 7.1b |
| LSD (.05) | 22.4 | 0.7 | 43.2 | 0.78 | 25.8 | 0.9 |

*Significantly different values are denoted by different letters
Table 1. Leaf fresh and dry weight (LFW, LDW, g/plant) lettuce cultivars, grown in recirculating hydroponic – NFT culture system

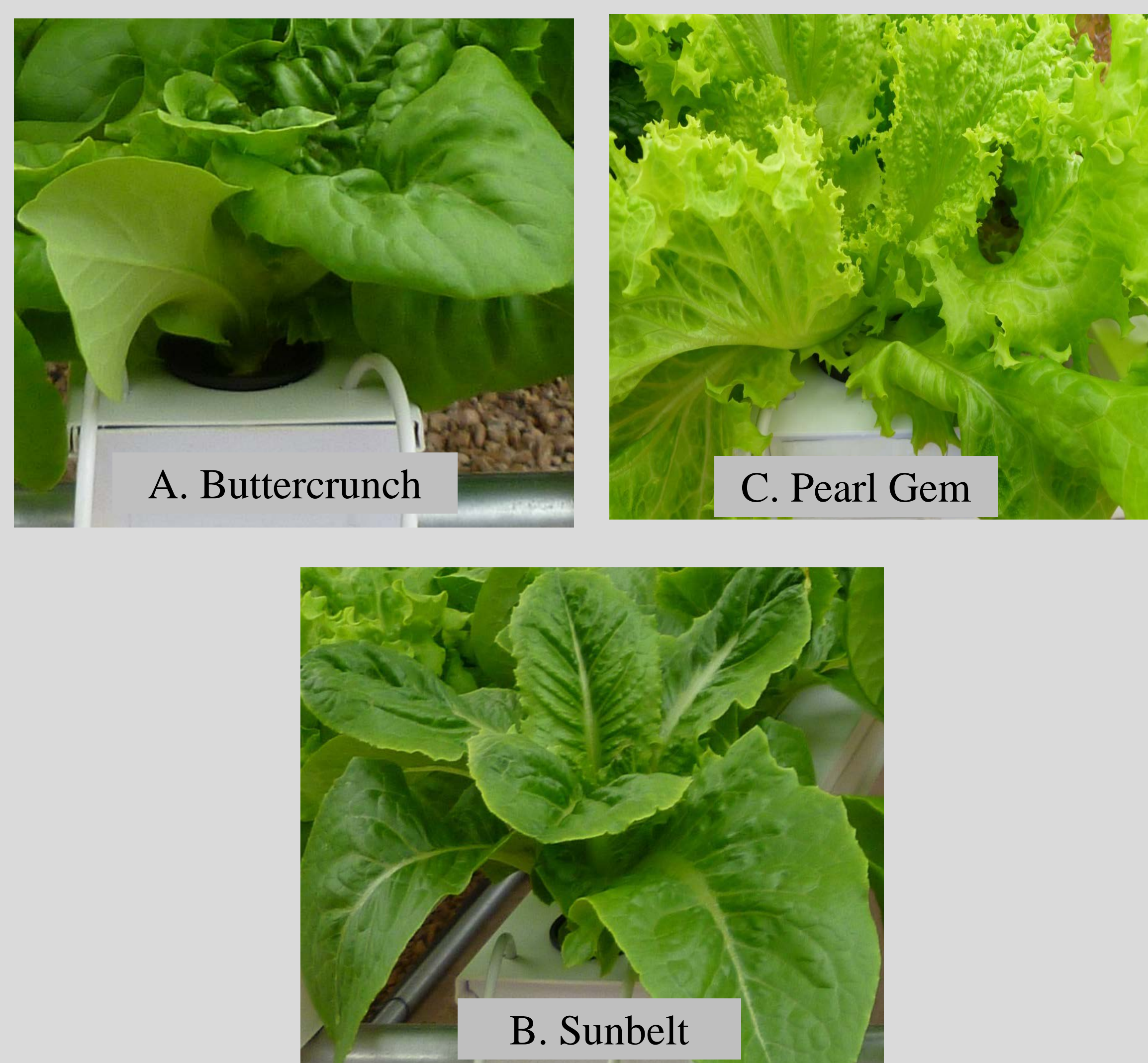


Figure 1. Most productive and water use efficient cultivars

Water use

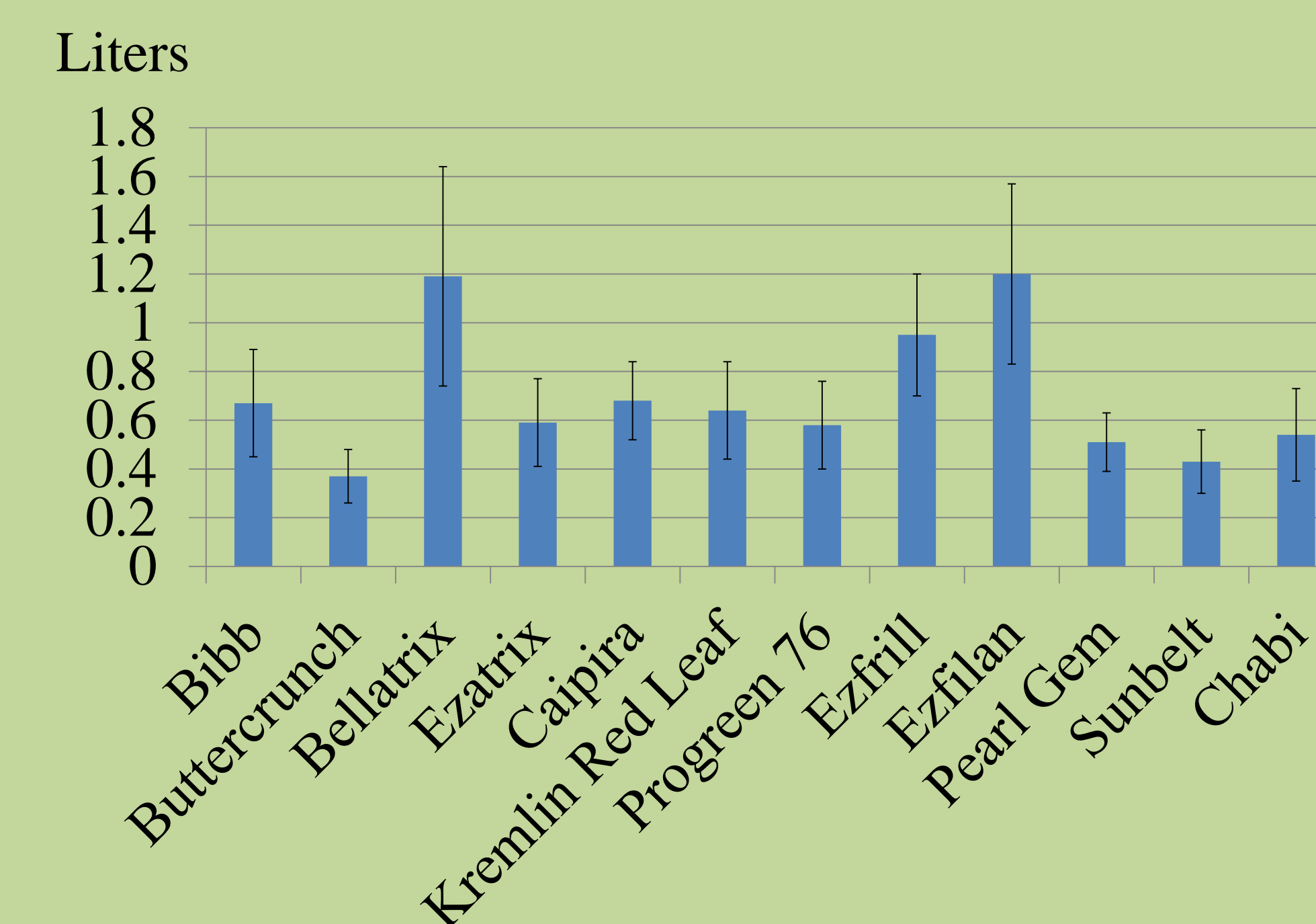


Figure 1. Water use efficiency (WUE, L.g⁻¹ DW) of lettuce cultivars in recirculating - NFT culture system (average of three cycles). Lower values indicate higher WUE.

Cultivar screening

- Bibb type:** 'Buttercrunch' (Fig. 1A) was the best lettuce with greatest WUE (0.37 L.g⁻¹ DW) of all cultivars, and 1.6 times higher productivity (plant weight, number and weight of leaves) than 'Bibb' (Table 1)
- Romaine type:** 'Sunbelt' (Fig. 1B) had better WUE (0.43 L.g⁻¹ DW) and was more productive than 'Chabi'.
- Loose-leaf types:** 'Pearl Gem' (Fig. 1C) had the best WUE (0.43 L.g⁻¹ DW) and was the most productive loose-leaf cultivar. 'Ezatrix', 'Caipira', 'Progreen' and 'Kremlin Red Leaf' had WUE from 0.58 to 0.68 L.g⁻¹ DW and moderate productivity. The cultivars 'Bellatrix', 'Ezfrill' and 'Ezfilan' had poor WUE (0.95-1.2 L.g⁻¹ DW) and the lowest productivity of all lettuce types grown in the NFT system.
- Bibb, Buttercrunch, Sunbelt and Chabi cultivars expressed moderate leaf tipburn injury during the first cycle.

Conclusions

- Screening lettuce cultivars for growth, WUE, and quality was effective in the NFT hydroponic culture system.
- Within each lettuce type and three growing cycles, the best cultivars based on highest WUE and growth were Buttercrunch (Bibb), Pearl Gem (Loose-leaf) and Sunbelt (Romaine).
- In conjunction with project partners (UCUWCD), we are conducting knowledge-based educational programs in hydroponic culture, crop water use and lettuce product quality.

Literature Cited

Leskovar D. I., C. Xu, S. Agehara, S. P. Sharma and K. Crosby, 2014. Irrigation strategies for vegetable crops in water-limited environments. J. of Arid Land Studies, 24-1, 133-136.

Acknowledgements

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Cultivar demonstration and technology transfer to producers