Ecological stoichiometry of horticulture: consequences of pruning and irrigation for plant and soil chemistry

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Nutrient use efficiency (NUE) measures an organism's capacity to grow (to incorporate carbon, C) per unit of resource (nitrogen, N, and phosphorus, P). Stressful environmental conditions may mandate a need for greater NUE in plants. In urban ecosystems, such stresses may derive from horticultural practices such as irrigation and pruning.

We used an experiment to test the general hypothesis that stressful conditions imposed by horticultural practices enhance plant NUE, measured as C:N and C:P ratios. Replicate individuals of both Texas sage (*Leucophyllum frutescens*) and oleander (*Nerium oleander*) were treated with high vs. low irrigation crossed with no pruning vs. pruning once per 6 weeks. Plant tissue chemistry was measured during both a damp, cool (February) and hot, dry (July) period. Research was conducted in an experimental plot at the Desert Botanical Gardens.

Hypotheses & Predictions

1) Pruning imposes a stress that generates enhanced NUE
   a) C:N & C:P ratios increase with pruning

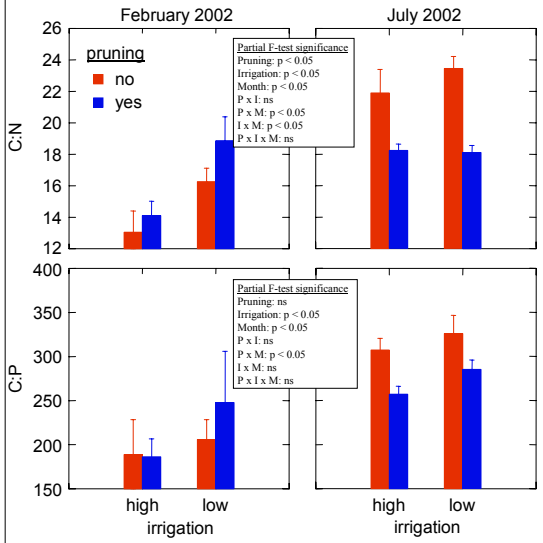
2) Irrigation relieves drought stress, thus reducing NUE
   a) C:N & C:P ratios decrease with irrigation
   b) C:N & C:P ratios greater in Jul. than in Feb.

3) Combined stress produced by pruning and drought is non-additive
   a) Irrigation suppresses the effect of pruning on nutrient ratios
   b) The effect of pruning is relatively small in February and is relatively large in July

4) Environmental conditions can mediate the extent to which horticultural practices stress plants
   a) Irrigation has a stronger effect on nutrient ratios in July than in February.
   b) Irrigation mediates the strength of the pruning effect in July, but does not mediate the strength of the pruning effect in July

5) Horticultural practices in urban ecosystems do not generate stress on plants
   a) Variability in plant nutrient ratios is not related to pruning or irrigation

Texas Sage – *Leucophyllum frutescens*



Hypothesis 1: Pruning imposes a stress that generates enhanced NUE
Prediction a: **NOT UPHELD.** C:N ratio greater in *unpruned* treatment & C:P ratio not affected

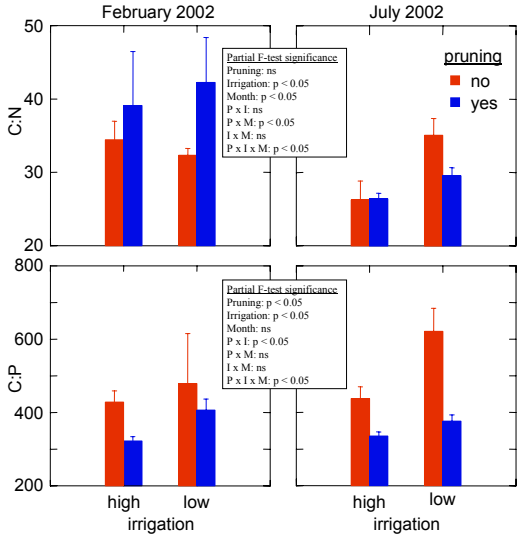
Hypothesis 2: Irrigation relieves drought stress, thus reducing NUE
Prediction a: **UPHELD.** C:N & C:P ratios greater in low irrigation treatment
Prediction b: **UPHELD.** C:N & C:P ratios greater in July

Hypothesis 3: Combined stress produced by pruning and drought is non-additive
Prediction a: **NOT UPHELD.** No pruning X irrigation interaction effect on C:N & C:P ratios
Prediction b: **AMBIGUOUS.** Pruning X month interaction effect on C:N & C:P ratios significant, but pruning effect opposite than predicted

Hypothesis 4: Environmental conditions can mediate the extent to which horticultural practices stress plants
Prediction a: **NOT UPHELD.** Influence of irrigation on C:N stronger in Feb than in Jul. No irrigation x month interaction effect on C:P
Prediction b: **NOT UPHELD.** No 3-way interaction effect on C:N or C:P

Hypothesis 5: Horticultural practices in urban ecosystems do not generate stress on plants
Prediction a: **NOT UPHELD.** Horticultural activities effects C:N and C:P, but not in the same way.

Oleander – *Nerium oleander*



Hypothesis 1: Pruning imposes a stress that generates enhanced NUE
Prediction a: **NOT UPHELD.** C:N ratio not affected and C:P ratio greater in *unpruned* treatment

Hypothesis 2: Irrigation relieves drought stress, thus reducing NUE
Prediction a: **UPHELD.** C:N & C:P ratios greater in low irrigation treatment
Prediction b: **NOT UPHELD.** C:N ratio greater in February & C:P ratio not affected

Hypothesis 3: Combined stress produced by pruning and drought is non-additive
Prediction a: **AMBIGUOUS.** No pruning X irrigation interaction effect on C:N. Pruning X irrigation interaction effect on C:P, but pruning effect opposite than predicted
Prediction b: **NOT UPHELD.** Enhancement of C:N owing to pruning is enhanced in Feb, suppressed in Jul. No pruning X month interaction effect on C:P.

Hypothesis 4: Environmental conditions can mediate the extent to which horticultural practices stress plants
Prediction a: **NOT UPHELD.** No irrigation x month interaction effect on C:N or C:P
Prediction b: **UPHELD.** In Feb, pruning affects C:N & C:P, but this effect is not mitigated by irrigation. This effect is, however, mitigated by irrigation in Jul.

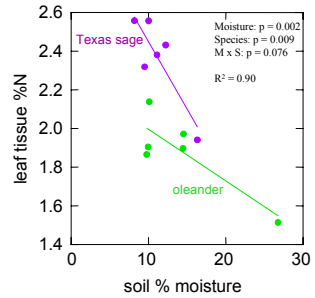
Hypothesis 5: Horticultural practices in urban ecosystems do not generate stress on plants
Prediction a: **NOT UPHELD.** Horticultural activities effects C:N and C:P, but not in the same way.

General Conclusions

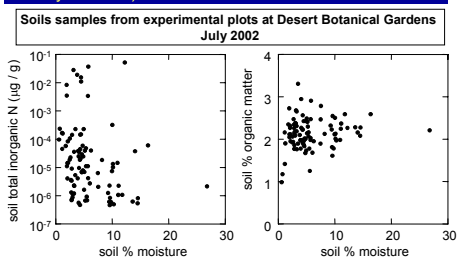
- Low water availability generally enhanced nutrient use efficiency.
- When multiple stressors affect nutrient use efficiency, their combined effects are non-additive.
- Forms of stress imposed by horticulture do not uniformly *enhance* nutrient use efficiency.

Future Hypotheses
mechanisms behind results?

- Though it may be a stress to plants, pruning decreases nutrient use efficiency because it selectively removes nutrient-rich foliage, leaving behind C-rich woody tissue.
- Low-water conditions enhance C:N in plants because:
  - ✓ Low water induces improved retention of N in plants



- ✓ Abundant water reduces N availability in soil by several mechanisms (leaching, stimulating uptake by bacteria)



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