In year 1, watermelon was dominant and did not undergo intense competition for light as seen visually in Fig. 2a and support...canopy in an architecturally complex system in year 1 (a) and year 2 (b).

**Hypothesis**

We hypothesized that as light competition intensity increased, watermelon would respond by increasing SLA, leaf N concentration, and PNUE.

**Methods**

- Two-year field study using 5 crop species (Table 1) and 3 replicates (field site and plot layout information can be found in Franco et al., 2015).
- In 2011, peanut was direct seeded on August 1st followed by watermelon on August 7th, okra and cowpea on August 14th and 15th and 3-inch tall pepper transplants on August 18th (plants spaced 30.5 cm apart).
- Due to overcrowding by watermelon in year 1, planting dates were altered and plants were directly seeded earlier in the season in year 2 (Peanut and okra on June 21st and 22nd, cowpea on June 27th; pepper transplants on July 3rd and watermelon on July 12th).
- Five controls of each species in monocrop were used. Six treatments used were: within-row intercropping systems consisting of: peanut and watermelon (Wpw), peanut, watermelon, and okra (Wpwo), peanut, watermelon, okra, cowpea, and pepper (Wpwoc), and a strip intercropping system consisting of peanut and watermelon in alternating single rows (Swp).
- Gas exchange was measured on the youngest fully expanded watermelon leaves between 1200 and 1400 at full canopy (69 and 94 days after planting in year 1 and year 2, respectively).
- Leaves were collected and scanned with a flatbed scanner to derive total leaf area, oven dried at 24°C for 48 hours, ground, and analyzed for C and N content.
- SLA was calculated as the ratio of leaf area (m²) to leaf dry mass (kg).
- PNUE was calculated as photosynthetic rate per unit leaf area (μmol CO₂ s⁻¹ m⁻²) / gram of N per unit leaf area (g N * SLA) to give μmol CO₂ [mol N]⁻¹ s⁻¹.
- Data were analyzed using ANOVA and regression analyses in JMP 10.0.2 software.

**Introduction**

- Intercropping with functionally diverse species is a way of mimicking nature, creating an architecturally complex and dense multi-layered canopy.
- Plants that form part of a more dense canopy undergo intense competition for light and respond by changing leaf morphology and altering resource allocation patterns.
- Specific leaf area (SLA), leaf area per unit dry mass, maximizes light interception by increasing relative growth rate, leaf N content, and, thus, optimizing photosynthetic capacity per unit leaf area.
- There is a strong relationship between SLA and leaf N, and SLA and photosynthetic N-use efficiency (PNUE; photosynthetic capacity per unit leaf N) as PNUE is associated with higher relative growth rate, thereby increasing plant fitness and the ability to compete with neighbors.

**Objective**

- To evaluate leaf-level acclimation and photosynthetic nitrogen-use efficiency in watermelon in a functionally diverse intercropping system.

**Results**

- In year 1, watermelon was dominant and did not undergo intense competition for light as seen visually in Fig. 2a and supported by the data (Fig. S3a, b, c).
- In year 2 when light competition was greatest due to okra dominance (Fig. 2b), watermelon acclimated by increasing SLA (e.g. larger but thinner leaves) and investing more N for rapid growth (higher leaf N concentration, lower CN) in treatments containing okra (Fig. S3a, b, c).
- No differences were found in watermelon PNUE between monocrop and intercropping treatments as was hypothesized (Fig. 3d).
- SLA was positively linearly correlated with leaf N concentration (Fig. 4a); however, no relationship was found between SLA and PNUE (Fig. 4b).
- Changes in PNUE within a species may be too small to detect and may be more pronounced when comparing species with different life strategies.
- Morphological plasticity demonstrated by watermelon in year 2 may play an important role in optimizing net CO₂ assimilation rates over the entire leaf, thus maximizing canopy-level photosynthesis and enhancing competitive ability.
- Enhancing competitive ability may, however, come at a cost as energy is reallocated from fruit production to growth as evident in lower watermelon yields in year 2 (Franco et al., 2015).
- With increasing interest in multifunctional intercrop and cover crop mixtures, these findings may inform selection of species and relative planting dates given how interspecific species interactions may alter leaf N allocation and C:N ratios and, subsequently, above-ground nutrient inputs.

**Table 1. Component crop characteristics**

<table>
<thead>
<tr>
<th>Crop</th>
<th>Variety</th>
<th>Family</th>
<th>Function</th>
<th>Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peanut</td>
<td>Limaspan 90</td>
<td>Fabaceae</td>
<td>nitrogen fixation, stoller crop</td>
<td>low/ mid growth form</td>
</tr>
<tr>
<td>Watermelon</td>
<td>TAMU mini</td>
<td>Lecithinacea</td>
<td>another crop, shading</td>
<td>low growth form</td>
</tr>
<tr>
<td>Okra</td>
<td>Clemson spineless</td>
<td>Malvaceae</td>
<td>pollinator attractant, structural support</td>
<td>tall growth form</td>
</tr>
<tr>
<td>Cowpea</td>
<td>Texas pinkeye</td>
<td>Fabaceae</td>
<td>nitrogen fixation, pollinator attractant</td>
<td>mid growth form</td>
</tr>
<tr>
<td>Pepper</td>
<td>jalapeño/Serrano</td>
<td>Solanaceae</td>
<td>pest barrier</td>
<td>mid growth form</td>
</tr>
</tbody>
</table>

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**Literature Cited**