Color of Light as a Signal for Plant Development: Far-red and Phytochrome

Paul Kusuma
Crop Physiology Laboratory
Plants, Soils and Climate

Photoconversion of Phytochrome chromophore

Pr

H₂N - pro his ser cys his leu gln - COOH

cis isomer

red light

Pfr

H₂N - pro his ser cys his leu gln - COOH

trans isomer

far-red light

In red light, the phytochrome is in Pfr (trans) form.
In far-red light, the phytochrome is in Pr (cis) form.

Source: http://plantphys.info/plant_physiology/images/pchromeforms.gif
<table>
<thead>
<tr>
<th></th>
<th>-Far-red</th>
<th>+Far-red</th>
<th>Full Sun</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Blue (400-499)</td>
<td>16</td>
<td>15</td>
<td>28</td>
</tr>
<tr>
<td>% Green (500-599)</td>
<td>16</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>% Red (600-699)</td>
<td>68</td>
<td>69</td>
<td>37</td>
</tr>
<tr>
<td>PPFD (400-700)</td>
<td>575</td>
<td>575</td>
<td>--</td>
</tr>
<tr>
<td>DLI (mol m(^{-2}) d(^{-1}))</td>
<td>37</td>
<td>37</td>
<td>30 - 50</td>
</tr>
<tr>
<td>% Far-red (700-750)</td>
<td><strong>1</strong></td>
<td><strong>13</strong></td>
<td>17</td>
</tr>
</tbody>
</table>
Leaf Area (cm$^2$): +66%
Leaf Dry Mass (g): +46%
Stem Dry Mass (g): +76%

Lettuce
- Far-red
+ Far-Red
Leaf Dry Mass ($m^2$): +17%
Stem Dry Mass (g): +105%
Petiole Length (cm): +115%

Soybean - Far-red  + Far-Red
Far-Red

Leaf Dry Mass (g):
+3%

Stem Dry Mass (g):
+56%

Height to Meristem (cm):
+47%

Tomato - Far-red  + Far-Red
Far-Red

Leaf Dry Mass (g): 0%
Stem Dry Mass (g): +157%
Height to Meristem (cm): +281%
Petiole Length (cm): +109%

Cucumber - Far-red + Far-Red
Leaf Dry Mass (g): +25%
Stem Dry Mass (g): +40%
Height to Meristem (cm): +3%
Petiole Length (cm): +77%

Pole-bean

- Far-red
+ Far-Red
Far-Red

- Leaf Dry Mass (g): -3%
- Stem Dry Mass (g): +5%
- Height to Meristem (cm): -0.6%
- Petiole Length (cm): -2%

Pea

- Far-red
- + Far-Red

*lots of variability*
Leaf Dry Mass (g): +22%
Stem Dry Mass (g): +31%

Corn
- Far-red
+ Far-Red
Leaf Dry Mass (g): -9%
Stem Dry Mass (g): +10%

- Far-red

+ Far-Red

Wheat
Questions?

Leaf Dry Mass

Stem Dry Mass

Percent Far-Red

Normalized Leaf Dry Mass

Normalized Stem Dry Mass

Wheat

Corn

Cucumber

Soybean

Lettuce

Tomato

Pole Bean

Pea

Pole Bean

Corn

Soybean

Cucumber

Lettuce

Tomato

Pole Bean

Corn

Wheat

Pea
8 days after emergence

- Far-Red

17 days after emergence

+ Far-Red

- Far-Red

+ Far-Red

- Far-Red
Blue light reduces leaf expansion and growth in red lettuce.