Short Communication

Phytochrome-Mediated Bud Development in *Pisum sativum*

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Summary. Light-grown dwarf peas were disbudded except for a single lateral bud, then transferred to darkness at 24°C. During the dark period the seedlings were irradiated daily for 5 or 7 min with R or FR. The buds exposed to R developed into shoots faster than those irradiated with FR. The R effect was FR reversible, and the FR effect was R reversible. The Pfr form of phytochrome thus promoted shoot growth including cell division, DNA and RNA synthesis.

Phytochrome (P) mediates many photomorphogenetic changes in plants. Such changes are stimulated by R light and reversed by FR irradiation. Bogorad and McIlrath (1960) and McIlrath and Bogorad (1960) found that axillary buds of *Xanthium* were developed when the plants were maintained under fluorescent light, and were repressed under incandescent light. We studied the effects of R light on single axillary buds of peas. These buds contain meristematic tissue in an inactive state; they grow only after removal of the actively dividing apical bud.

The experiments were conducted with 8-day-old dwarf pea (*Pisum sativum* L. cv. Little Marvel) seedlings grown in the light in growth chambers. The terminal and the lateral buds were removed except for the bud at the second node; this will be called "target bud". Seedlings with a target bud were irradiated for 5 or 7 min daily with R, FR, R followed by FR, or FR followed by R, and then placed in darkness. A temperature of 24°C was maintained during the experimental period. The sources of R and FR during the irradiation were similar to those described by Khudairi and Arboleda (1971). The light treatments were continued for 2, 4, 6 or 8 days, and the growth of the newly formed shoots was measured in several ways—length, fresh weight, cell number and total nucleic acids. For cell counts, shoots were collected 48 or 96 hours after treatment, fixed in ethanol-acetic acid-formaldehyde, dehydrated in ethanol, imbedded in paraffin, sectioned and stained with Safranin-Fast green (Sass, 1958). Nucleic acids were extracted and analyzed according to Smillie and Krookov (1960).

7 min of R enhanced the growth of the target bud into a well-developed shoot, while shoots which received FR lagged behind (Fig. 1). Table 1

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*Abbreviations*: R = red; FR = far-red; P = phytochrome.
Table 1. Effect of red light and far-red on the growth of the target bud and the third internode of Pisum sativum cv. Little Marvel.

8-day-old, were light-grown seedlings irradiated once a day with 7 min of red and far-red and then kept in the dark at 24°C. The figures represent mean values of 10 plants with standard deviation. Measurements were made on the fifth day from the beginning of the R or FR treatment.

<table>
<thead>
<tr>
<th>Light treatment</th>
<th>Developing lateral shoot (mm)</th>
<th>3rd internode of main shoot (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>6.7 ± 0.20</td>
<td>13.9 ± 0.45</td>
</tr>
<tr>
<td>FR</td>
<td>3.4 ± 0.24</td>
<td>16.9 ± 0.55</td>
</tr>
<tr>
<td>R + FR</td>
<td>2.8 ± 0.20</td>
<td>16.1 ± 0.29</td>
</tr>
<tr>
<td>FR + R</td>
<td>6.0 ± 0.15</td>
<td>14.1 ± 0.37</td>
</tr>
<tr>
<td>Dark</td>
<td>2.7 ± 0.14</td>
<td>15.7 ± 0.25</td>
</tr>
</tbody>
</table>

shows that, while internode elongation in the main shoot was—as usual—inhibited by R and enhanced by FR, development of the axillary shoot from the target bud was affected in the opposite manner. After 5 days from the first day of R treatment, this shoot was growing twice as fast as after FR treatment (6.7 versus 3.4 mm). The promotive effect of the R was FR reversible, and the FR effect was reversed by R. The experimental treatments were compared with dark controls.

The better growth of the lateral shoots is also expressed in their fresh weight. In one experiment, 8-day-treated seedling shoots developed from target buds following R irradiation had a mean fresh weight of 205 mg while shoots developed following FR treatment weighed only 171 mg per shoot.

Cell numbers were counted in median longitudinal sections of the apical dome of the target bud (Table 2). The cell number in the meristematic regions was higher in the R-treated shoots, e.g., 26–30 cells from the top of the dome to the second leaf primordium in the R-treated shoots and only 12–17 cells in the FR-treated ones.

More DNA and total RNA was found in the R-treated than in the FR-treated shoots; and the level increased from the 2nd to the 6th day from the beginning of the experiment. The higher RNA content of the target buds was detectable 48 h after R irradiation. By the 6th day, total RNA in the R-treated shoots was 54 µg RNA/shoot, as compared to only 18 µg RNA/shoot in the FR-treated ones.

The FR-absorbing form of phytochrome (Pfr) seems to have two distinct and opposite effects on shoot growth: (1) inhibition of hypocotyl (Downs, 1955) and internode elongation (Downs et al., 1957; Thomson, 1959); and (2) enhancement of cell division in the meristematic region. Increases in cell number after R irradiation have been demonstrated here