LETTUCE SEED GERMINATION:
A PHYTOCHROME-MEDIATED INCREASE IN THE GROWTH
RATE OF LETTUCE SEED RADICLES

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Summary. The rate of straight growth in mannitol of the axial portion of 2 differ-
ent samples of photosensitive lettuce seeds was followed after red and far-red irra-
diation. If the growing half-seeds were classified into proportions of the sample that
had undergone a growth increment greater than a certain, selected value, growth
rate was found to be enhanced by red light and this enhancement paralleled the
phytochrome-mediated increase in the rate of appearance of a geotropic curvature
in seed axes, an effect which had been previously reported. The increase in the rate
of growth of the radicle by red light was limited to early growth. Once extension
has exceeded a certain value the rate of further growth is independent of the state
of phytochrome.

Introduction
In previous experiments (SCHEIBE and LANG, 1965) with the radicle
portion (“half-seed”) of photosensitive lettuce seed (Lactuca sativa L.,
ev. “Grand Rapids”), freed from mechanical restriction to expansion by
the endosperm, it was shown that the growth potential of the embryo is
increased subsequent to irradiation with red light (R), this red-light
effect being reversible by far-red (FR). The response was evident with
half-seeds imbibed in water, but the difference between red-and far-red-
treated material was greatly enhanced by applying a water stress by
imbibing the half-seeds in a solution of mannitol, which served as an
osmoticum.

The response which was observed in the earlier work was the geo-
tropic curvature of the radicle. There have been contradictory reports
regarding the relative growth rates of roots held in the normal position,
and roots geotropically stimulated (HERING, 1904; KEEBLE et al., 1931;
LARSEN, 1953; RUFELT, 1957). It has also been reported that there is an
interaction of the phytochrome system with geotropic reactions in the
maize coleoptile (WILKINS and GOLDSMITH, 1964). Because of these re-
ports, it was thought desirable to confirm the earlier findings on the effect
of R and FR on the growth potential of the embryo by studying the
effects of R and FR light on the straight growth rate of the half-seed in
mannitol, and to compare it with the rate of appearance of geotropic
curvature.
**Materials and Methods**

In order to facilitate measurements, the osmoticum (0.46 M mannitol) was supplied in 1.5% agar in a petri dish.

In one study, seeds of lot 164R20 were utilized. This lot was considerably less dark-dormant than the other (Table 1) but possessed the desirable attribute of being coatless (doubtless a result of the cleaning process), which made precise measurements of the axis size possible. The dry half-seeds were arranged in parallel rows on the agar surface and given the appropriate light treatment after 2 hours of imbibition. Thereafter, the dishes were kept in an upright position, so that the radicles, not being exposed to a geotropic stimulation, would grow straight. The lengths of the half-seeds at different times after the beginning of imbibition were measured to the nearest 0.03 mm at a magnification of 20 (transmitted bright-green light), with the aid of an ocular micrometer. Appropriate actinic irradiation (R or FR) was re-administered after each observation. Half-seeds, treated in exactly the same manner, except that the petri dishes were stored in a horizontal position and the observations were made in dim green incident light, served for a concurrent determination of the geotropic curvature response. The incubation temperature was 20°.

For the second study, seeds of the more dark-dormant lot 163R18 were used. The treatments were exactly the same as for lot 164R20, except that after 2 hours of imbibition the half-embryos were removed from the fruit coat by gentle pressure on the radicle end since it was impossible to measure the radicle length while the half-embryos were still enclosed in the fruit coat. The half-seeds to be used for concurrent determination of the curvature response were left intact, since it was previously shown (Schéime and Lang, 1965) that removal from the coats makes no essential difference in the rate of development of a geotropic curvature. The incubation temperature with lot 163R18 was 25° throughout.

The light sources and irradiation times were as previously described (Schéime and Lang, 1965).

**Results and Discussion**

The qualitative nature of the method of scoring the curvature response implies that a half-seed that has responded has undergone a minimum mean increase in length. The straight growth measurements on lot 164R20 were accordingly classified into proportions of the entire sample whose growth had exceeded certain, arbitrary values at each of the five observation points in time, and the data appear in Table 2. A comparison

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**Table 1. Germination response of two different lots of grand rapids lettuce seed at two different temperatures**

Germination was counted after 3 days dark incubation following the light treatment, which was 10 minutes R or 5 minutes FR given after 1.5 hours imbibition. Sample size, 300—600 seeds.

<table>
<thead>
<tr>
<th>Seed lot</th>
<th>Temperature</th>
<th>Light treatment</th>
<th>Germination (percent)</th>
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<td>R</td>
<td>99</td>
</tr>
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<td></td>
<td></td>
<td>FR</td>
<td>21</td>
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<td></td>
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<td>R</td>
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<td></td>
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<td>FR</td>
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<td>none</td>
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<tr>
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<td>20°</td>
<td>R</td>
<td>98</td>
</tr>
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Schéime and Lang, 1965.