Acta, Bot Neerl. 25(2), April 1976, p. 149–152.

ACTION SPECTRA FOR PHYTOCHROME-MEDIATED GERMINATION OF LETTUCE SEEDS (LACTUCA SATIVA L.)

G. BLAAUW-JANSEN and O. H BLAAUW

Botanisch Laboratorium, Utrecht

SUMMARY

The action spectrum for light-induced germination of thermo-dormant lettuce seeds in shifted to longer wavelengths in comparison to the action spectrum for far-red dormant seeds.

1. INTRODUCTION

Lactuca sativa L. seeds of cv.Noran germinate in darkness as well as in light. However, when the seeds are pretreated by exposure to temperatures above 30°C (which pretreatment induces thermodormancy) or by exposure to continuous far-red light (which pretreatment induces far-red dormancy) a short red exposure is necessary for germination. *Fig. 1* shows that for thermo-dormant seeds the response threshold for red irradiation is several orders of magnitude lower than for far-red dormant seeds (BLAAUW-JANSEN & BLAAUW 1975). This shift of the response threshold might be due to a difference in phytochrome content. If so the action spectra for red induction should be identical for thermo-dormant and far-red dormant seeds.

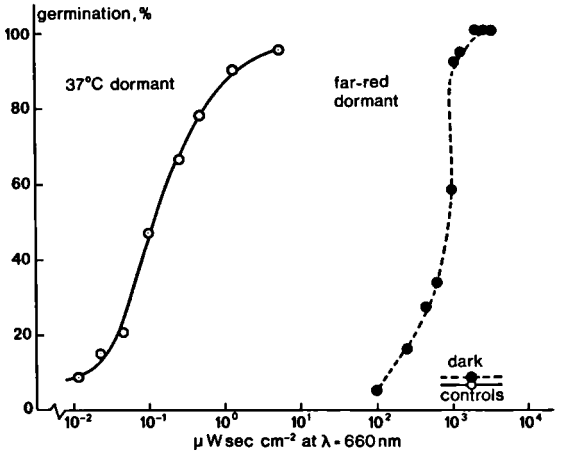

Fig. 1. Dose-response curves for induction of germination of lettuce seeds ("Noran"). Dormancy was induced either by long exposure to far-red light or by exposure to 37°C. Horizontal lines indicate germination percentages of the dark controls.

2. MATERIAL AND METHODS

The methods to induce dormancy in *Lactuca sativa* seeds (cv. Noran) were the same as in an earlier paper (BLAAUW-JANSEN & BLAAUW 1975). Light of various wavelengths was supplied by an incandescent (iodine)lamp with an appropriate system of lenses and a 5 cm layer of water. The beam was filtered through a combination of a precision double-band filter ("DEPAL", Schott u. Gen., Mainz), a precision line filter ("PIL", Schott u. Gen.) and a polarizing filter. "PIL" line filters have a half-band width (HW) of ca 10 nm, the band width at one thousandth of the maximum transmission (TW) is 9 HW; "DEPAL" double band filters have a HW of ca 16 nm, but TW/HW = 3.5. So combination of a "PIL" with a "DEPAL" brings about a transmission curve with a HW of 10 nm and a TW of 40 nm. The transmission maxima of the filters were spaced at intervals of 20 nm. By placing the interference filters obliquely to the direction of the light beam monochromatic light of intermediate wavelengths could be produced. As obliquely placed filters transmit polarized light in contrast to perpendicularly placed filters a polarizing filter was added as the last component in the optical system. The intensity was varied between 0.05 μW cm^{-2} and 10.0 μW cm^{-2} by introducing NG (type neutral) filters (Schott u. Gen.), the duration of irradiation never exceeded 8 minutes.

3. RESULTS

Before dose-response curves for each wavelength were determined the validity of the reciprocity law was checked, for thermo-dormant as well as for far-red dormant seeds (*fig. 2*). Reciprocity appeared to be holding for the exposure times used.

Next dose-response curves such as those of *fig. 3* were obtained for each

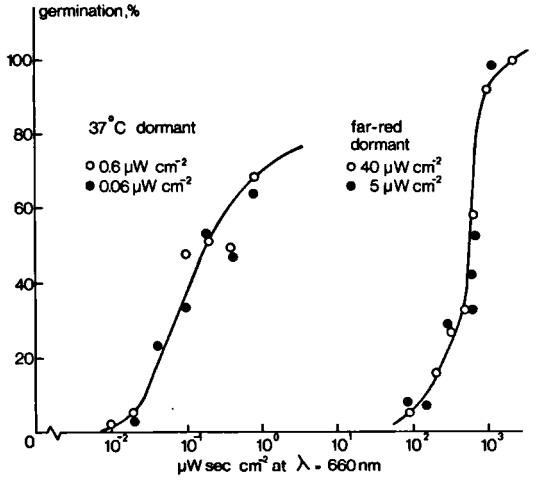

Fig. 2. The relation between germination percentage and quantity of red light of different intensities for thermo-dormant and far-red dormant lettuce seeds.

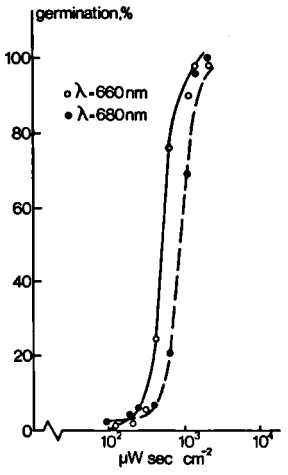

Fig. 3. Dose-response curves for induction of germination of far-red dormant lettuce seeds by light of different wavelengths.

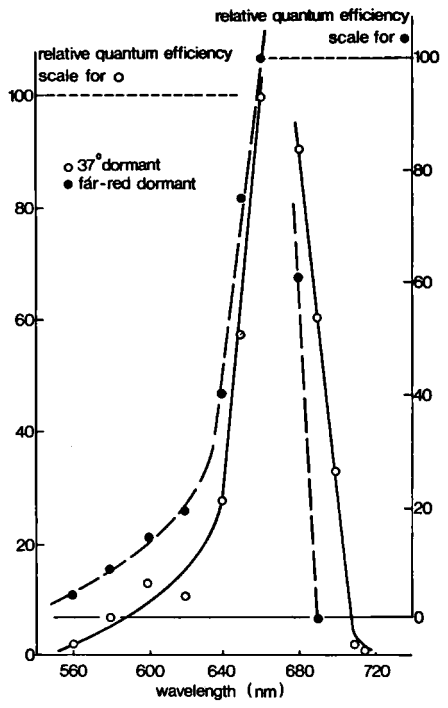

Fig. 4. Action spectra for the induction of germination in thermo-dormant resp. far-red dormant lettuce seeds.

wavelength. In each set of dose-response curves the curve for 660 nm was included as a standard. The quantity of energy required for a germination percentage to a level of 50% of the maximum was read on the abscissa. For the construction of the actionspectrum $\frac{E^{660}m^{-2}}{E^{\lambda}\ m^{-2}} \times 100$ was plotted against wavelength (*fig. 4*).

4. DISCUSSION

The action spectrum for the induction of germination of thermodormant lettuce seeds is shifted to longer wavelengths in comparison with the action spectrum for far-red dormant seeds (*fig. 4*). In a previous paper (BLAAUW-JANSEN & BLAAUW 1975) we demonstrated that thermo-dormant lettuce seeds react to much smaller quantities of red light than far-red dormant seeds. At the time we considered the supposition that this difference in sensitivity to light would be due to a difference in phytochrome content as unlikely. The above demonstrated dissimilarity of the action spectra confirms our opinion that rather two phytochrome species are operative in lettuce seeds. These phytochrome species

can not be associated with seed- resp. seedlings phytochrome since KENDRICK & SPRUIT (1974) reduced the seed-phytochrome concept to the presence in seeds of phytochrome intermediates. However, the possibility that the inductive effect of light on the germination of lettuce seeds would be mediated by phytochrome intermediates is not likely because the lettuce seeds had been imbibed at the least for 20 hours before irradiation, whereas the occurrence of these intermediates between P_r and P_{fr} is restricted to dehydrated or partially dehydrated seeds.

The shift of the actionspectrum of thermo-dormant seeds to longer wavelengths implies an unusual large inductive effect of far-red light (BLAAUW-JANSEN & BLAAUW, to be published). A great variability of the ratios of the effectiveness at 660 nm and at 730 nm is reported for the phytochrome action spectra published in literature (BLAAUW et al. 1968, RAVEN 1973), but the relation between the shapes of the action spectra and the inductive activity of far-red light is not often discussed. HAUPT (1968) reported that the efficacy of induction by far-red of phytochrome-mediated chloroplast movement in *Mougeotia* is relatively high. This is connected with an abnormal action spectrum: "with a maximum shifted slightly to longer wavelengths and a drop to the far-red by far not as fast as is usually known". However, for the shorter wavelengths no shift of this action spectrum was found. Therefore the interpretation of Haupts experiments gives us no support in the interpretation of our results.

ACKNOWLEDGEMENT

We thank Mrs J. C. van Hall-Coops for faithful and reliable assistance.

REFERENCES

BLAAUW, O. H., G. BLAAUW-JANSEN & W. J. VAN LEEUWEN (1968): An irreversible red-light-induced growth response in Avena. *Planta* **82:** 87–104.

BLAAUW-JANSEN, G. & O. H. BLAAUW (1975): A shift of the response threshold to red irradiation in dormant lettuce seeds. *Acta Bot. Neerl.* **24:** 199–202.

HAUPT, W. (1968): Die Orientierung der Phytochrom-Moleküle in der Mougeotiazelle: Ein neues Modell zur Deutung der experimentellen Befunde. *Z. Pfanzenphysiol.* **58:** 331–346.

KENDRICK, R. E. & C. J. P. SPRUIT (1974): Inverse dark reversion of phytochrome: An explanation. *Planta* **120:** 265–272.

RAVEN, C. W. (1973): *Chlorophyll formation and phytochrome.* Thesis, Wagemingen.