

BRIEF COMMUNICATIONS

RED-LIGHT-INDUCED GERMINATION OF LETTUCE SEEDS: RELATIONSHIP BETWEEN START OF VISIBLE GERMINATION AND FLUENCE

G. BLAAUW-JANSEN and R. SEWMAR

Vakgroep Algemene Plantkunde, Lange Nieuwstraat 106, 3512 PN, Utrecht.

During the incubation in darkness of positive photoblastic seeds processes occur that increase the effectiveness of light, in particular of red light (R), in causing germination of these seeds. There is evidence in the literature that in the pre-irradiation (dark) period the primary site of reaction of the far-red absorbing form of phytochrome (Pfr) or the substance(s) with which Pfr reacts are formed (KOLLER *et al.* 1964, KARSSSEN 1967, 1970). We investigated for lettuce seeds the possibility that this preparatory reaction is directly under control of Pfr, a possibility that was not considered by Koller *et al.* for *Artemisia monosperma* seeds nor by Karssen for *Chenopodium album* seeds.

Materials and methods were according to BLAAUW-JANSEN & SEWMAR (1985). Dormancy was induced in *Lactuca sativa* L. 'May Queen' seeds by imbibition under continuous FR. Germination was induced by irradiation with a high or a low fluence of R, either immediately after the imbibition period or after a dark period of 24 h. The exposure times were 60 s (0.2 W m^{-2}) or 40 s (0.03 W m^{-2}). After the exposure to R the seeds were returned to darkness and every 30 min 2 dishes were removed for counting without illuminating the remaining dishes. The results of the experiments, expressed in percentages germination, are means of 2 dishes. In order to restrict the periodically counting of the germinated seeds within a reasonable time of the day the dishes for each experiment were divided into 3 sets. The start of the imbibition of each set was timed at different hours with the effect that counting during 8 h gave the course of germination during 26 to 40 h after irradiation. This implies that each curve representing the course of germination is build up out of 3 overlapping parts. As the overlapping parts were in good agreement it was thought unnecessary to repeat the experiments.

Fig. 1 shows the time course of germination of dormant seeds after irradiation with 12.0 J m^{-2} or 1.2 J m^{-2} of R. When R was given immediately after the

Abbreviations – R, red light; FR, far-red light; Pfr, far-red absorbing form of phytochrome; [Pfr], Pfr level.

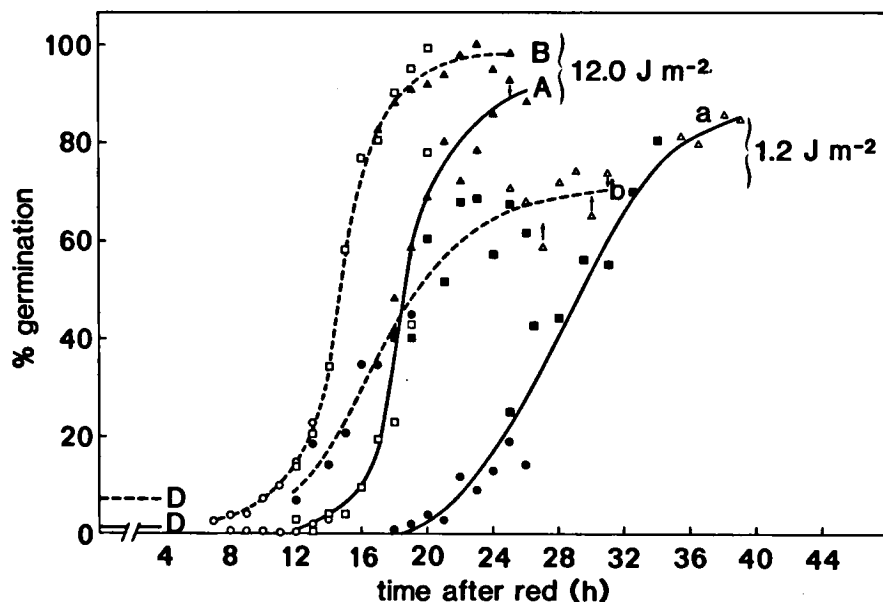


Fig. 1. The influence of a saturating and a non-saturating R fluence and the influence of insertion of a dark pre-irradiation period on the time course of germination.

- A no pre-irradiation dark period; fluence: 12.0 J m^{-2}
 B a 24 h pre-irradiation dark period; fluence: 12.0 J m^{-2}
 a no pre-irradiation dark period; fluence: 1.2 J m^{-2}
 b a 24 h pre-irradiation dark period; fluence: 1.2 J m^{-2}

imbibition period under FR, the first visible germination occurred c. 14 h after an irradiation with 12.0 J m^{-2} , but not before c. 20 h after an irradiation with 1.2 J m^{-2} (fig. 1, curves A and a). The slopes of the curves A and a are not the same, indicating a more uniform germination of the population after a saturating fluence (inducing 100% germination) than after an unsaturating one (inducing 80% germination). When a dark interval was inserted between the imbibition under FR and the germination-inducing R treatment the radicles protruded c. 10 h after R for both fluences (fig. 1, curves B and b), but the difference in slopes of the curves is still obvious. Our results suggest that in lettuce seeds reactions, preparatory for the germination-inducing action of Pfr, can take place in darkness, but that these reactions are enhanced by Pfr.

In a previous study (BLAAUW-JANSEN & SEWMAR 1985) we demonstrated the effect of various R fluences on the start of the escape from FR-reversibility in lettuce seeds. The escape started after a lag time of c. 6.5 h in response to a low R fluence (1.2 J m^{-2}). The lag time was shortened with c. 3.5 h by irradiating the seeds with a higher R fluence (12.0 J m^{-2}). This difference of 3.5 h in the start of the escape cannot explain the difference of c. 6 h in the start of germination after these R fluences. Presumably the high-fluence seeds had to wait only c. 11 h after the escape for the completion of the preparatory reactions, the

low-fluence seeds on the other hand c. 13.5 h thus it might be concluded that [Pfr] regulates two steps in the germination process.

Another argument for the above hypothesis can be derived from the slopes of the germination curves (*fig. 1*) and the slopes of the escape curves (BLAAUW-JANSEN & SEWMAR 1985). The slopes of the escape curves were nearly similar for low-fluence and high-fluence seeds. The slopes of the germination curves however are steeper for high-fluence seeds than for low-fluence ones (*fig. 1*). Thus the comparable uniformity in the escape of high-fluence and low-fluence populations is lost in the ultimate germination process. This loss is under control of [Pfr] as the slope of the germination curves is dependent on [Pfr]. These data fit in with our above conclusion: the lag in the start of the escape reaction is controlled by [Pfr]; the escaped seeds can only pursue the germination process after a preparatory reaction (also controlled by [Pfr]) is completed.

REFERENCES

- BLAAUW-JANSEN, G. & R. SEWMAR (1985): Red-light-induced germination of lettuce seeds: relationship between escape from reversibility and fluence. *Photochem. Photobiol.* **42**: 705–709.
- KARSSSEN, C. M. (1967): The light-promoted germination of the seeds of *Chenopodium album* L. I. The influence of the incubation time on quantity and rate of the response to red light. *Acta Bot. Neerl.* **16**: 156–160.
- (1970): The light-promoted germination of the seeds of *Chenopodium album* L. V. Dark reactions regulating quantity and rate of the response to red light. *Acta Bot. Neerl.* **19**: 187–196.
- KOLLER, D., M. SACHS & M. NEGBI (1964): Germination-regulating mechanisms in some desert seeds. VIII. *Artemisia monosperma*. *Plant Cell Physiol.* **5**: 85–100.