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RED LIGHT ENHANCES THE GROWTH OF AVENA COLEOPTILES

J. LION

Botanisch Laboratorium, Utrecht

SUMMARY

A 3 hours lasting irradiation with red light 27 hours after moistening of *Avena* seeds does not repress the growth of the mesocotyls completely. A second irradiation with red light 72 hours after moistening further reduces mesocotyl growth. In contrast red light enhances slightly but significantly the growth of the coleoptiles. Total seedling growth is reduced.

1. INTRODUCTION

MUIR (1972) and MUIR & CHANG (1974) report that red light inhibits the growth of intact *Avena* coleoptiles. The latter state that this is a general phenomenon, quoting PJON & FURUYA (1967), who found the same with rice coleoptiles, and they correlate it with a decrease in the synthesis of IAA in the tip of the coleoptile.

However, it has generally been found that red light enhances the growth of intact *Avena* coleoptiles and only inhibits the growth of mesocotyls (VAN OVERBEEK 1936; JOHNSTON 1937; SCHNEIDER 1941; CURRY et al. 1956; BLAAUW 1961; MER & CAUSTON 1967; BLAAUW et al. 1968; MER 1972). ROESEL & HABER (1963) have found the same with wheat seedlings, as did HUISINGA (1967) in short lasting experiments with isolated seedlings (mesocotyl + coleoptile) of *Avena* grown in total darkness. BLAAUW et al. (1968) have investigated the same phenomenon as MUIR & CHANG (1974), but they found a small enhancement of the growth of the coleoptile by red light and a stronger inhibition of the growth of the mesocotyl. This result has frequently been reproduced in class experiments in this laboratory.

Much less agreement exists about the influence of red light on the growth of coleoptile sections, but an enhancement of the growth of coleoptile sections has repeatedly been reported (LIVERMAN & BONNER 1953; AGHION et al. 1962; HUISINGA 1964; HOPKINS & HILLMAN 1965, 1966; HILLMAN 1966; HOPKINS & BONNELL 1969; HOPKINS 1972). BLAAUW-JANSEN & BLAAUW (1966) have reported that red light, given shortly before sectioning, enhances the plasticity of Avena coleoptile sections. In contradistinction with intact seedlings PJON & FURUYA (1967) have found an enhancement of the growth by red light with tip sections of rice coleoptiles.

It is true that red light decreases the final length of coleoptiles, but this effect is reached only after 8–10 days (DU BUY & NUERNBERGK 1929; DE LINT 1957).

The experiments quoted were done with 3–5 days old coleoptiles.

A possible explanation of the different results of MUIR & CHANG (1974) is that the growth reduction they found with intact seedlings was localized in the mesocotyl instead of in the coleoptile, because the irradiation with red light given at the beginning of the cultivation period to inhibit the mesocotyl growth was possibly not sufficient to effect this completely.

To test this assumption *Avena* seedlings were raised in a light regime similar to that of MUIR & CHANG (1974), but after the second irradiation with red light the growth of coleoptiles and of mesocotyls was followed separately.

2. MATERIALS AND METHODS

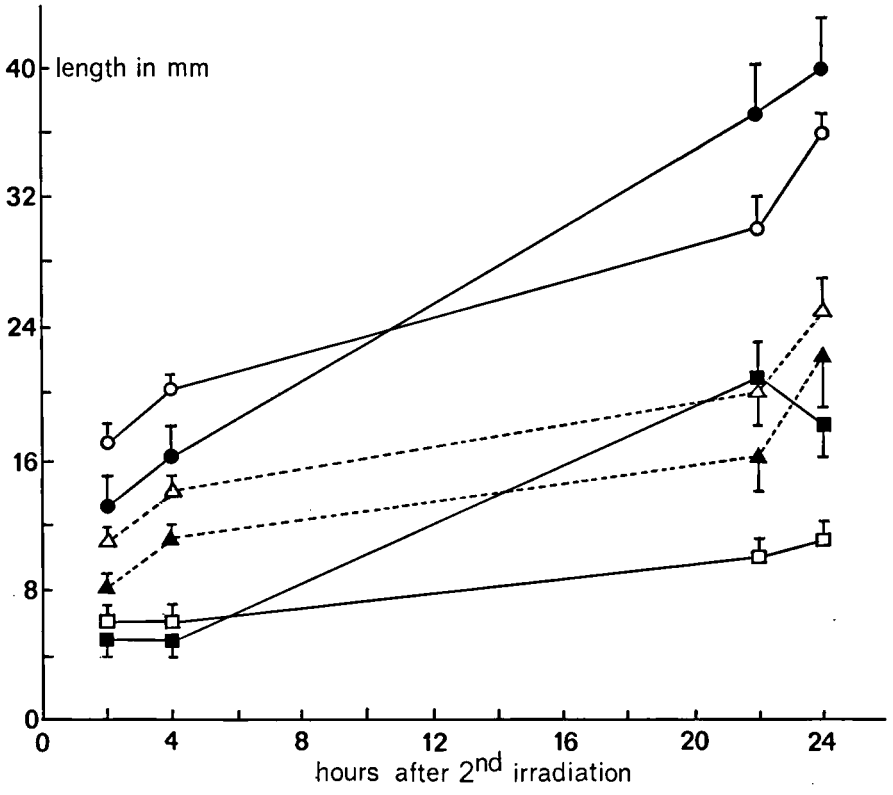
The plants were grown on glass strips wrapped in filterpaper and put in glass trays with an inclination of 30° as described by BLAAUW & BLAAUW-JANSEN (1964); 8 trays with about 25 plants each were used. Except for the experimental irradiations they were kept in the dark. No working light was used.

27 hours after moistening of the seeds the plants were irradiated with red light for 3 hours (40 W red fluorescent tube, Philips TL 15, filtered by 3 mm red perspex, Röhm und Haas 601; intensity on the level of the plants 0.4 Wm^{-2}). 72 hours after moistening of the seeds 4 trays were irradiated again with the same light during 15 minutes. After the irradiation the trays were put back in the dark. 2, 4, 22, and 26 hours after the irradiation one irradiated and one non-irradiated tray at a time were taken into daylight and the length of the mesocotyls and coleoptiles were measured separately. Then the plants were discarded. Thus, all data are from different trays.

3. RESULTS AND DISCUSSION

The *figure* shows that the growth of the seedling is clearly inhibited by red light. However, this inhibition is localized in the mesocotyl. The growth of the coleoptile is slightly enhanced. In contradistinction to the data of MUIR & CHANG (1974) these phenomena are not evident after a few hours, because for each measurement new plants were taken, whereas MUIR & CHANG followed the growth of the same plants.

The only difference in treatment of the plants that may be relevant is that in our experiment during both irradiations the mesocotyls were irradiated directly, whereas in the experiments of MUIR & CHANG (1974) this was only the case during the first irradiation. However, LANGE (1929) has already shown, that irradiation of the coleoptile only inhibits the growth of the mesocotyl. One may conclude, therefore, that the production of auxin in the coleoptile tip may be correlated with the growth of the mesocotyl. This correlation has been demonstrated by VAN OVERBEEK (1936) with *Avena* seedlings of which the growth of the mesocotyl was inhibited by so-called dark-room illumination ($\lambda > 575$ nm) and with seedlings of *Zea mays* of which the mesocotyls were inhibited by heat.



Length of whole seedlings ○ – ○ – ○, mesocotyls □ – □ – □, and coleoptiles △ ... △ ... △. Open symbols irradiated twice; closed symbols irradiated once. The bars indicate the 95% fidelity intervals, calculated by multiplying the standard deviation of the mean by $t_{0.05}$ for the appropriate number of degrees of freedom.

Besides a decrease of the growth, red light causes a redistribution of the growth in the *Avena* seedling. In rice this decrease and redistribution of the growth may be entirely localized in the coleoptile (PJON & FURUYA 1967; FURUYA et al. 1969). As this is accompanied by an enhancement of the growth of the coleoptile, the interpretation by MUIR & CHANG (1974) of the influence of red light "as an effect on the enzyme system synthesizing IAA, or as an effect on the availability of the substrate, tryptophan, for the synthesis" is oversimplified. The mechanism suggested by HUISINGA (1964, 1967) better takes into account the whole complex of phenomena.

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