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## RED-BLUE LIGHT INTERACTION IN THE RESPONSE OF *SINAPIS* ALBA SEEDLINGS TO THE EXOGENOUS GIBBERELLIN

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The interaction between blue and red light in the response of mustard seedlings to the exogenous GA<sub>3</sub> has been studied. It was found that under certain fluence rates of red and blue light plants respond to a hormone as they were grown in darkness, namely as if the phytochrome were not operating. The application of herbicide SAN 9787 prevented this interaction.

Key words: *Sinapis alba*, light, phytochrome, cryptochrome, interaction, gibberellic acid.

Ključne reči: *Sinapis alba*, svetlost, fitohrom, kriptohrom, interakcija, giberečna kiselina.

### INTRODUCTION

The elongation of green seedlings is known to be affected, in some species, by two different parts of the spectrum, i.e. by red and by blue light (Black and Shuttleworth, 1974; Gaba and Black, 1979; Thomas and Dickinson, 1979). The presumed photoreceptors, phytochrome and cryptochrome, operate also in other cases such as chlorophyll accumulation, anthocyanin synthesis and protonemal elongation. In these processes different modes of interaction between the two receptors have been demonstrated (Morr, 1980). While phytochrome has been characterized, the cryptochrome is still defined only operationally by its action spectrum, its molecular identity being not established. Nevertheless, a great deal of evidence points to a flavoprotein as a sensor pigment for the blue part of the spectrum (Lipson, 1975; Delbrück *et al.*, 1976).

The explanation of the action of light in morphogenesis has been repeatedly sought in terms of its interaction with plant hormones (Black and Vlitos, 1972; Wareing and Thompson, 1976). In etiolated or weak red light – grown mustard seedlings no significant interaction was found between light and exogenously applied gibberellins (Mohr and Appuhn, 1962). However, a strong interaction was observed when seedlings were grown in continuous light: the stronger the light effect the smaller is the growth increment caused by  $GA_3$ . In addition, the dose response curve for  $GA_3$  was biphasic (Konjević *et al.*, 1980). The obtained results also showed that in weak white light the response was very similar to the one obtained in darkness. This result was the basis for the present study aimed at investigating the possible interaction between blue and red light (cryptochrome and phytochrome) in the extension of  $GA_3$  – treated seedlings.

## MATERIAL AND METHODS

Seeds of *Snapsis alba*, harvest 1975, were obtained from Asgrow Company (Freiburg–Ebnet, W. Germany). The seeds were sown and the seedlings raised following the standard procedure for photomorphogenic research with mustard seedlings (Mohr, 1966), except that they were grown in Hoagland's nutrient solution. The experimental temperature was 25°C. From the time of sowing the seedlings were kept under continuous white light for 48 h. After that period they were transferred to different light regimes for additional 12 h.

Red, far-red and blue light were applied at energy fluence rates of 0.68, 3.5 and 3.12  $W \cdot m^{-2}$  (Schaffer, 1977). Before transfer to darkness, a group of seedlings was irradiated with 5 min 756 nm light ( $7 W \cdot m^{-2}$ ) obtained using AL interference filters from Schott (Mainz, W. Germany), half bandwidth 21 nm. White light (17.000 lx), with spectral distribution very similar to sunlight, was obtained from xenon arc (Osram XQO, 10 kW). It was filtered through a 3 mm heat-absorbing (KGI) and 6 mm Thermopane glass.

$GA_3$  was purchased from Fluka (Buchs, Switzerland) and herbicide sandoz 9789 (SAN 9789) was obtained as a gift from Sandoz (Bazel, Switzerland). Gibberellic acid (3.5 ml per box), dissolved in Hoagland's solution, was administered 48 h after sowing by transferring the upper layer of the germination paper, which carried the seedlings, to a new box with 3 layers presoaked in 5 ml  $GA_3$  in Hoagland's solution. The water content of the germination paper with seedlings was accounted for in calculating the  $GA_3$  concentrations. SAN 9789 was applied from the time of sowing.

## RESULTS AND DISCUSSION

The data presented here confirm phytochrome – hormone interaction and point to a significant interaction between red and blue light in the same process (Figs. 1 and 2). It is obvious that, in all light regimes, except in 1/10 WL and darkness, with operating phytochrome, a strong inhibition of  $GA_3$  action occurred. However, in 1/10 WL the seedlings responded as they were grown in darkness, namely where phytochrome was removed from the system by the pulse of 756 nm light at the end of WL pretreatment. It seems that at fluence rate of 1/10 WL the type of equilibrium between blue and red light portion of the spectrum was established which blocked the operation of phytochrome

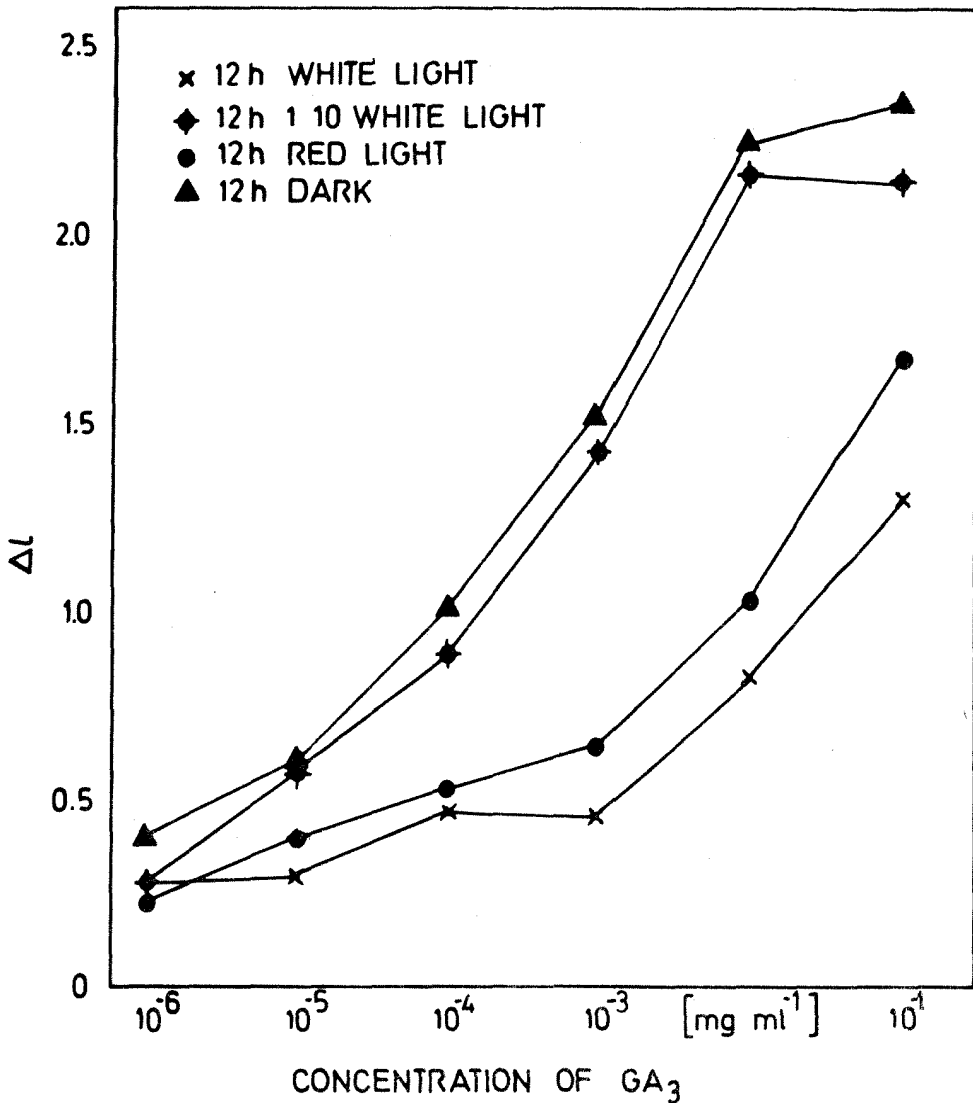


Fig. 1. — Hypocotyl elongation in continuous light between 48 and 60 h after sowing. The growth increment caused by GA<sub>3</sub> is plotted against GA<sub>3</sub> concentration („dose”).

and therefore abolished its effect on GA<sub>3</sub> action. This view was further corroborated by the results of experiments where seedlings were grown 12 h in the presence of different GA<sub>3</sub> doses under simultaneous irradiation with red and blue light of the fluences indicated in section Material and Methods. The obtained dose response curve was similar to the ones for dark and 1/10 WL grown seedlings (Fig. 3). However, the effect of 1/10 WL on the response to GA<sub>3</sub> was abolished if seedlings were treated (from the time of

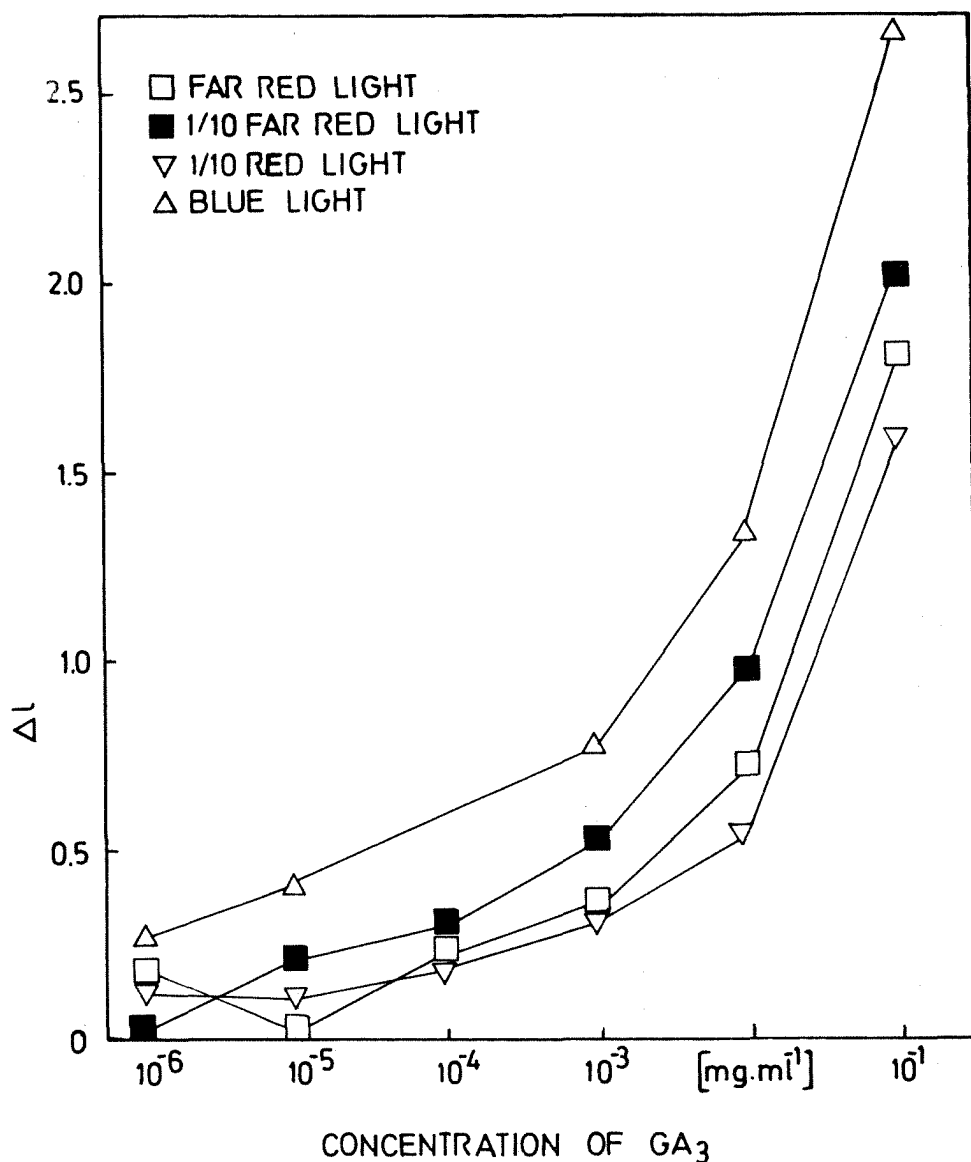


Fig. 2. — The effect of continuous far-red, 1/10 far-red, 1/10 red and blue light on hypocotyl elongation between 48 and 60 h after sowing. The growth increment caused by GA<sub>3</sub> is plotted against GA<sub>3</sub> concentration („dose”).

sowing) with SAN 9789. Saturating part of the curve is lost (Fig. 4).

The obtained results fit into the hypothesis that blue receptor blocked the action of phytochrome since the herbicide might had a direct effect at the receptor level. There is no direct evidence to support this hypothesis but it is favoured by the results obtained

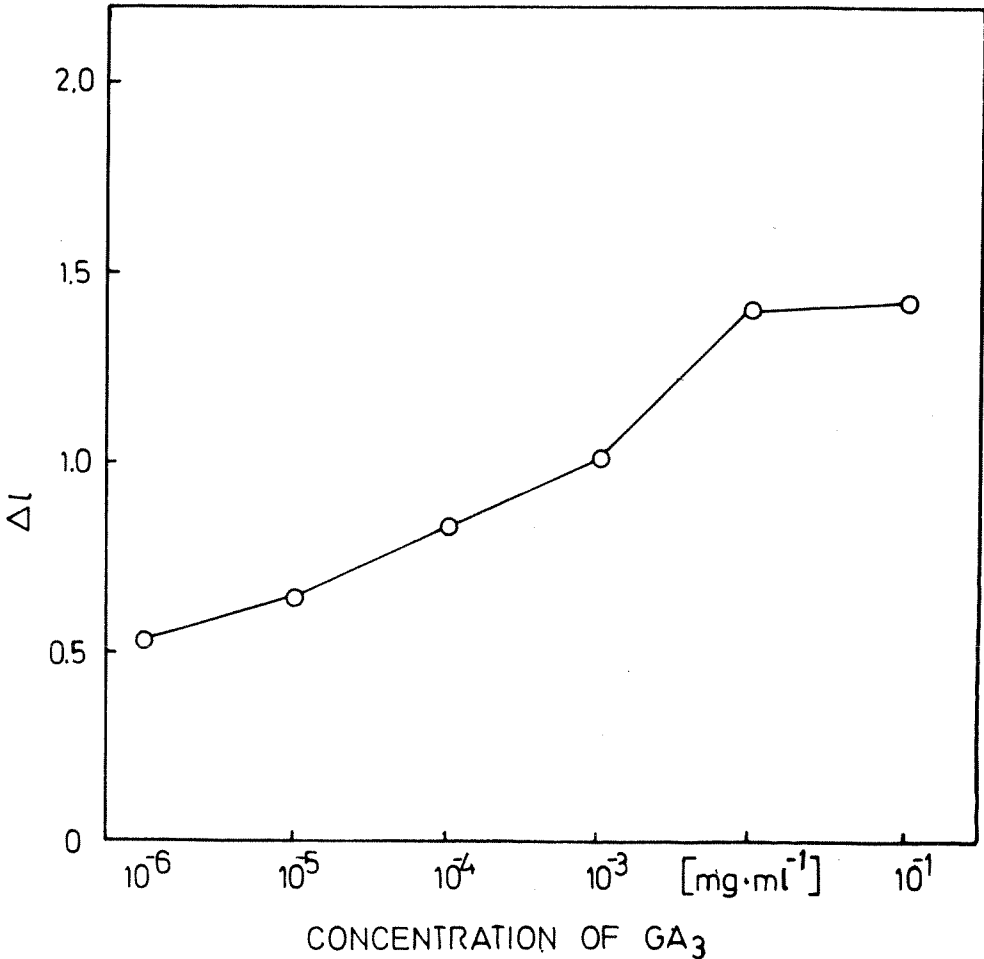


Fig. 3. - The effect of simultaneous irradiation with blue and red light on hypocotyl elongation between 48 and 60 h after sowing. The dose response curve is a steady function similar to the ones for 1/10 WL and darkness in Fig. 1. Energy fluence rates were as indicated in Material and Methods.

in preliminary experiments on the effect of SAN 9789 on light induced absorbance changes (LIAC) in white light grown seedlings of *Phaseolus aureus* (O b r e n o v i ć *et al.*, 1983). It seems that the herbicide impaired the reduction of cytochrome b 557, a component of the proposed blue light receptor (M u n o z and B u t l e r, 1975).

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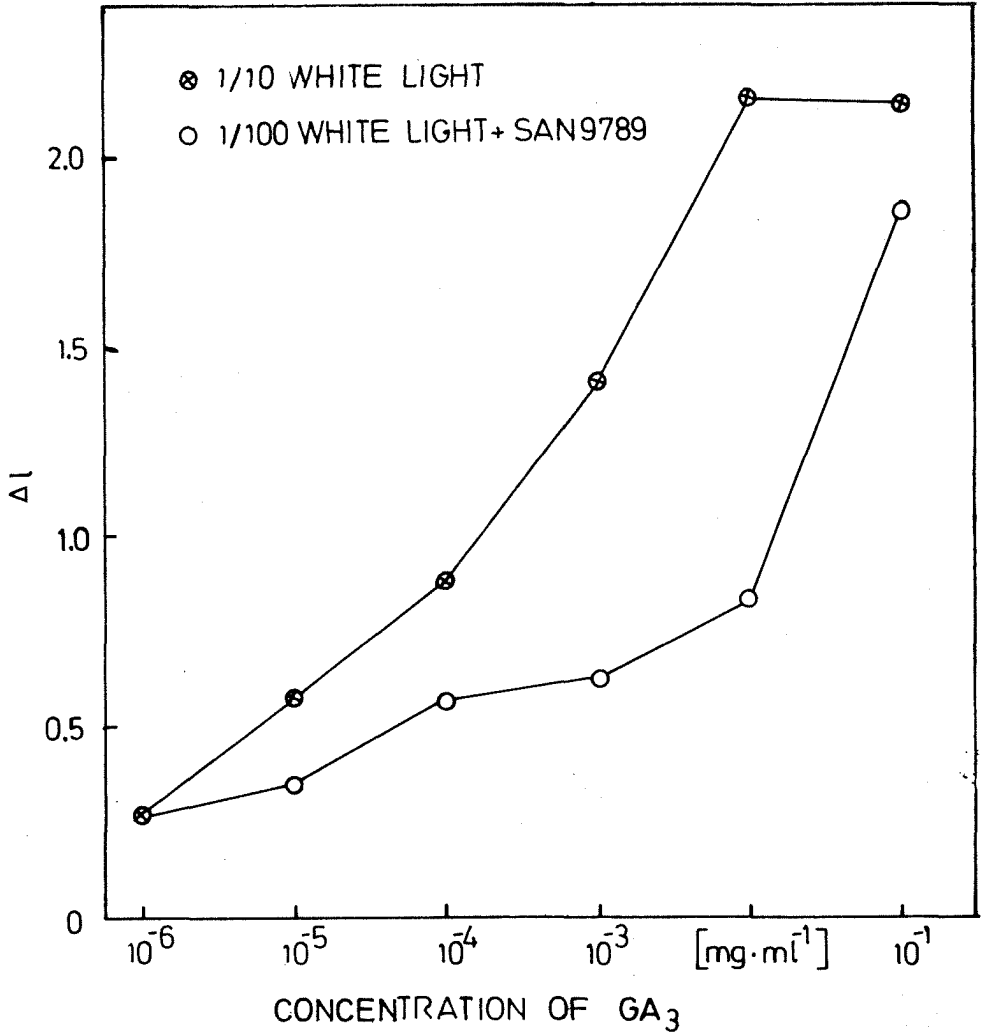


Fig. 4.— The effect of SAN 9789 on hypocotyl elongation in continuous white light between 48 and 60 h after sowing. 1/100 WL was applied to compensate for the chlorophyll screening effect in control plants.

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### Re z i m e

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#### INTERAKCIJA CRVENE I PLAVE SVETLOSTI U REAKCIJI SEJANACA SINAPIS ALBA NA EGZOGENI GIBERELIN

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Ispitivana je interakcija crvene i plave svetlosti u kontroli izduživanja sejanaca *Sinapis alba* tretiranih različitim koncentracijama  $GA_3$ . Utvrđeno je da, kada se biljke istovremeno osvetljavaju određenim intenzitetom crvene i plave svetlosti, sejanci reaguju kao da su gajeni u mraku, odnosno kao da je fitohrom neaktivan. Primena herbicida SAN 9789 sprečava ovu interakciju.