STUDIES ON THE LIGHT SENSITIVITY OF PLANTAGO MAJOR L. SEEDS III. THE EFFECT OF LIGHT COLOUR AND INTENSITY

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(Received December, 1967)

Introduction

It has been noticed that Plantago major seeds are light-sensitive and that increasing the quantity of light delivered to the seeds increases their percentage of germination (T a d r o s and R e z k, II, 1966). This was confirmed by an experiment to test the effect of the depth of sowing on the germinability of those seeds, the results of wich showed that decreasing the depth at which the seeds were sown increased the degree of emergence of the seedlings. On the other hand, the different colours of light are known to affect the germination especially that of light-sensitive seeds.

In this paper a trial is made to elucidate the effect of prolonged exposure of the germinating seeds of P. major to red, blue, and white light at different intensities.

It is a well known fact that red light stimulates the germination of light-sensitive seeds (e.g. *Lactuca sativa* seeds) although for the seeds of *Plantago major* it was shown that this colour had no promoting effect on their germination in the dark (R e z k II, 1968).

E v e n a r i et al (1957) using three types of monochromatic light sources have reported that the three types of blue light showed identical behaviour in that they inhibited the germination in the first few hours before promoting it after 10 hours of imbibition. Blue light is also reported to have a retarding effect on seed germination and it even simulates far-red light in nullifying the promoting effect of red light on the germination of *Lactuca sativa seeds* (W a r e i n g and B l a c k, 1958; B l a c k and W a r e i n g, 1960).

Materials and Methods

Three incubators were equipped with fluorescent lamps to deliver white, red, and blue light. The highest light intensity was 10 000 erg (cm^2) sec, and lower light intensities were obtained by putting layers of white translucent paper on the Petri-dishes themselves or on the basins containing them. These added layers were examined and proved to act as neutral filters. The technique used for preparing the Petri-dishes is exactly the same as that described before (Rezk II, 1968). The seeds received light of the desired colour and intensity for 10 hours daily inside the incubators. Four light intensities were obtained: 10 000, 7000, 3000, and 200 erg (cm^2) sec. For each light intensity in each colour 200 seeds were used distributed into four Petri-dishes. The whole was 48 Petri-dishes containing a sum of 2400 seeds. The seeds were of 1967 crop.

After 15 days the basins were opened and the germination percentages calculated. It was intended not to count the germinating seeds daily in order not to expose the seeds to different light intensities that may disturb the light regime to which the seeds were exposed.

Results and Discussion

The results are graphically illustrated in Fig. 1. It is clear from this figure that increasing the intensity of any colour of light resulted in the increase of the germination percentage of *Plantago major* seeds.

The germination percentage at the red light occupied always the highest position at all intensities. The behaviour is in concordance with the findings of other authors working upon the germination of light-sensitive seeds.

White light gave results that were intermediate between those of the red and the blue except at the highest intensity of 10 000 erg (cm^2) sec where it resulted in the lowest germination percentage at that intensity. This peculiar behaviour was suspected to be an experimental error and so the exposure to the three light colours at this high intensity was repeated twice and was found consistent. To explain such a result it may be said that this is a sort of inhibition of germination at such a high intensity of white light. Similar effects of high doses of white light have been previously observed by Mittal and Mathur (1965) on tomato seeds. These authors mentioned that continuous irradiation of tomato seeds resulted in poor germination while the reduction of the amount of white light delivered to the seeds resulted in better germination.

Blue light gave results that were always the lowest except at the highest intensity where its effect was more promotive than that of white light. Borthwick et al. (1952) obtained both promotion and inhibition of germination of lettuce seeds by blue radiation depending upon the duration of the period the seeds have been allowed to imbibe water prior to irradiation (citation from Wareing and Black, 1958). As mentioned before, Evenari et al. (1957) have reported a promoting effect of blue light on germinating seeds. Czopek (1963) observed a similar effect of chromatic blue light when the germination of turions of *Spirodela polyrrhiza (Lemnaceae)* was enhanced and promoted by a daily ten minutes exposure to blue light although to a lower extent as compared to the promotion by white light. These findings coincide fairly here with our findings as regards the seeds of *Plantago major*.

In a trial to explain such results on the basis of the modern 'Low Energy Reaction' and 'High Energy Reaction' theories (M o h r, 1962), it can be said that the germination of *Plantago major* seeds is neither a strictly typical low energy reaction nor is it a strictly typical high energy one. Tthat it is not a low energy reaction is clear from the action of red light from interference filter which did not promote the dark germination of those seeds even when they were exposed to red light for a whole hour (R e z k II, 1968). On the other hand, that it is not a typical high energy reaction is vedidenced by the decline shown by the germination curve when the seeds were exposed to a relatively high intensity of white light.

Concluding from the studies on the light sensitivity of the seeds of *Plantago major,* we can say that this factor (light) plays an important ecological role in its survival and distribution, of course besides the other ecological factors (e.g. temperature, soil moisture, etc.). To get a successful set of seedlings of *Plantago major* seeds an adequate supply of light is needed to fulfil the great need of those seeds to that type

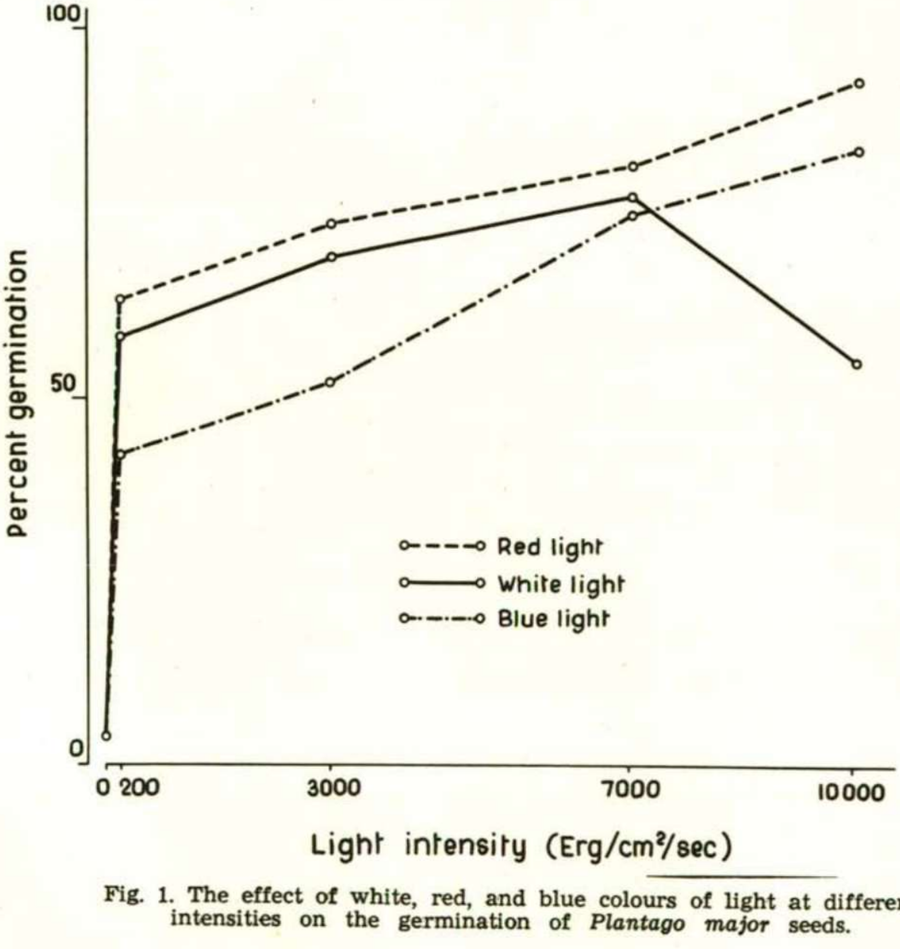

Fig. 1. The effect of white, red, and blue colours of light at different intensities on the germination of *Plantago major* seeds.

of energy. This is only available if the other ecological factors are optimal and if the seeds are not deeply sown below the soil layers. In Egypt this plant is characteristic of canal banks which form a type of favourable habitat for the settlement of *Plantago major* plants. The soil in such habitat is not regularly disturbed by ploughing practices and the shed seeds are always on or very near to the soil surface. Under such moist conditions of canal bank habitats the seeds receive their adequate requisites of water, oxygen, temperature, and light and so succeed to colonise such places. Their germination usually takes place late in autumn and so the quantity of light energy received by the germinating seeds is just adequate.

Summary

The effect of white, red, and blue colours of light on the germination of the seeds of *Plantago major* is studied. It is found that red light promotes the germination to the highest level followed by white and blue colours. The effect of white light at the highest intensity (10 000 erg (cm^2) sec) is inhibitory to the germination of those seeds.

The results are discussed in the light of the low energy reaction and the high energy reaction theories. The ecological bearing of the light-sensitivity of those seeds on the distribution of *Plantago major* is commented on.

Acknowledgment

This research was carried out during a fellowship from the Hungarian government to one of us (M. Rezk) for which he is greatly thankful.

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