# THE IMPORTANCE OF THE RED-FAR RED ANTAGONISM IN PHOTOBLASTIC SEEDS

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SUMMARY

In white light filtered through leaves the ratio red – far red is strongly shifted to the far red side. Such light prevents germination of photoblastic seeds.

Several species of weed seeds were investigated. It is concluded that the spectral composition of the light in a forest must be very important for the density and the composition of the undergrowth.

A great many species of plants have seeds which are more or less photoblastic. These seeds germinate in light and don't germinate in darkness. It is generally recognised that this may be a very important property to survive. If for instance in spring at a certain temperature all seeds of a certain species would germinate and this were followed by an extreme drought or a fire, all young plants would be destroyed. If the seeds are photoblastic only a few will have germinated and as soon as the drought will be over another few which have now been exposed to light by wind, earthworms or by other causes, will germinate.

As we know, such seeds, however small they are, can survive in the soil in an imbibed state for many years; very illustrative is a paper by WESSON & WAREING (1967) who discovered that in the soil under a well kept and 6 years old grass lawn some 23 species of our most common weeds still had viable seeds which germinated when exposed to light.

MAYER & POLJAKOFF-MAYBER (1963) stressed the importance of this property for the seeds but at the same time they wrote: "Even more difficult to explain is the function of the red-far red mechanism in regulating germination. On information at present available it is impossible to see what possible ecological function is associated with this mechanism" (p. 197–198).

The purpose of this paper is to show that this phytochrome mechanism is also very important for survival even in seeds which are seemingly not photoblastic.

Photoblastic seeds don't germinate in darkness; still less will they germinate in far-red light. But a great many non-photoblastic seeds which will eventually germinate for 100% in darkness, can be completely inhibited by far red. Some instances are tomato, cucumber (SPRUIT & MANCINELLI 1969), *Calotropis procera*, *Ruellia tuberosa*, *Bidens cynapiifolia*, *Mentzelia aspera*, *Synedrella nodiflora* (VAN ROODEN *et al.* 1970), but there are a great many more.

So one can state that most plants with seeds which are not too large, show a strong tendency not to germinate in far red light.

Phytochrome-regulated processes are dependent on the photostationary

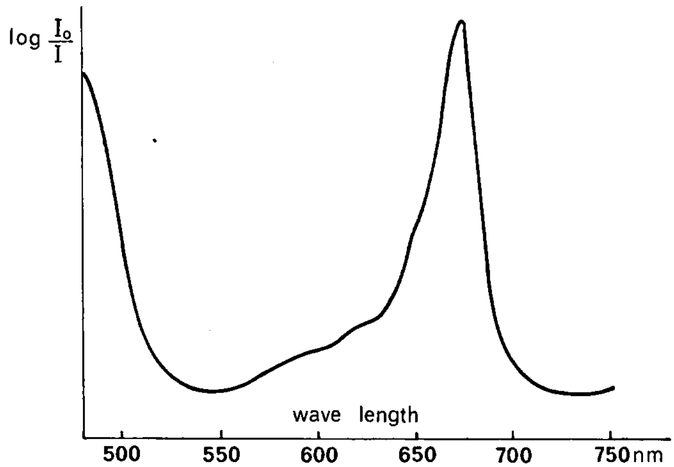


Fig. 1. Absorbtion of chloroplasts (after THOMAS 1965).

states of phytochrome (ratio $P_{fr}/P_{total}$). This ratio depends on the ratio red to far-red in the incident light. Sunlight has a ratio red/far-red of about 10/9. This is a ratio to induce germination in photoblastic seeds.

But when this sunlight is filtered through a leaf most of the red and blue light is absorbed while only a few per cent of the green and yellow is absorbed and of the far-red the absorption is still less (*fig. 1*). Dr. O. H. Blaauw from this laboratory measured transmission of far-red and red of some leaves. His data confirm clearly that after the daylight has passed through leaves the ratio far red/red radiation has changed very much to the far red side (*table 1*).

CUMMING (1963), already pointed out that in the shade of a tree the relative amount of far red increased very much, while VEZINA & BOULTER (1966) measured about 8 times more far red than red radiation in a maple forest. M. BLACK (1969) showed a very clear peak at 730 nm in the transmission spectrum of *Tilia* leaves. Black also noticed that the germination of lettuce seeds is inhibited when the light which they receive is filtered through these leaves.

To investigate whether the light in a forest has ecological importance because of its spectral composition we examined the germination of a number of seeds

Table 1

| Wave length | Transmission 660 nm | Transmission 735 nm | Ratio red/ far red |
|---|---|---|---|
| Dioscorea leaf | 2% | 10% | 1: 5 |
| Hibiscus leaf | 0,2% | 8% | 1:40 |
| Alocasia leaf | 0,7% | 13% | 1:20 |

Table 2

| Species | Germination in % | | | |
|---|---|---|---|---|
| | light | far-red filter | leaf filter | dark |
| Ruellia tuberosa | 100 | 0 | 0 | 100 |
| Calotropis procera | 100 | 0 | 0 | 100 |
| Portulaca oleracea | 75 | 0 | 0 | 4 |
| Hyptis atrorubens | 80 | 0 | 0 | 75 |
| Ageratum conyzoides | 60 | 0 | 0 | 0 |
| Tibouchina longifolia | 65 | 0 | 0 | 0 |
| Plantago major | 12 | 0 | 0 | 0 |

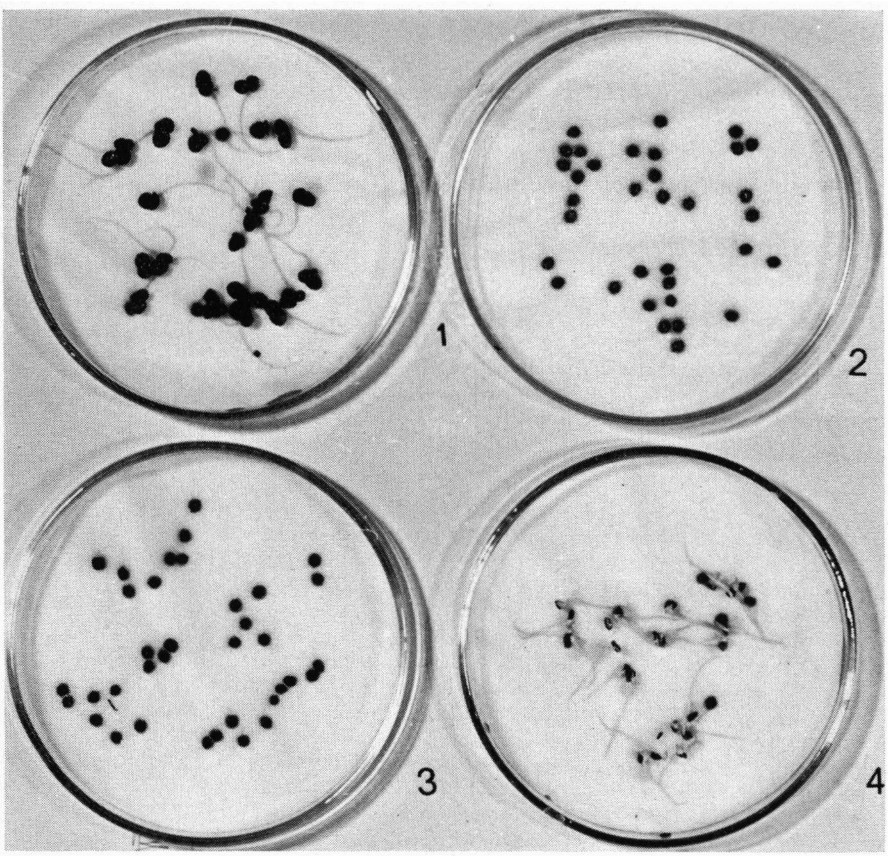


Fig. 2. Germination of seeds of *Ruellia tuberosa* L. in white light (1), in far red light (2), in light through an *Alocasia* leaf (3) and in darkness (4). The picture was taken 10 days after beginning of imbibition.

in light filtered through a leaf. The leaf used was an *Alocasia* leaf, chosen because of its large size. As seeds we selected some species which germinated in darkness as well as in light, and some which germinated only in light. The results are shown in *table 2*. *Fig. 2* shows the germination of *Ruellia tuberosa* seeds under these four conditions.

To show that light under a vegetation inhibits germination of many seeds we put *Ruellia* seeds in petri dishes on wet filter paper in different places in our greenhouse. Under dense vegetation there was no germination at all, in light beside the vegetation there was 100% germination after four days. In complete darkness we got the same result as in white light.

This experiment was repeated with seeds of *Digitalis* which germinate in light but not in darkness and not in far red. These seeds also showed no germination under dense vegetation nor under a single green leaf.

Of course the intensity of the light in a forest is much less than in the open. But as seed germination is dependent on phytochrome it is not the light intensity but the ratio red/far red which is important.

It is clear that light filtered through leaves strongly inhibits germination of many seeds because of the dominance of the far red over the red in the spectrum. It inhibits even germination of several seeds which germinate very well in darkness.

This might be the reason why aftei cutting a forest the soil is very soon covered by an abundance of plants, probably from seeds which had lain there dormant already during several years.

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