USE OF INSULFILM® LIKE PLASTIC FILTER TO SIMULATE CANOPY FILTERED LIGHT FOR GERMINATION TESTS

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ABSTRACT

The use of Insulfilm® like plastic filter for simulation of canopy filtered light was tested by germination of seeds of *Arctium lappa* L. (Asteraceae). The combination of plastic filter and 25W incandescent lamp gave the similar theoretical photoequilibrium of phytochrome as the shade of *Myrtus communis* L. canopy. Both canopy filtered (shade) light and plastic filtered light inhibited seed germination. Then, we concluded that the Insulfim® like plastic filter combined with incandescent lamps can be used in laboratorial seeds germination tests for simulation of canopy filtered light.

Key words: artificial filter, phytochrome, seed germination, *Arctium lappa*, canopy.

INTRODUCTION

The canopy filtered light is rich in far red radiation, above 700nm, due to differential absorption of short wavelengths by leaves [6]. This change in the spectrum of sun light when filtered by canopy can be monitored by red:far red ratio (R:FR) which is perceived by plants through phytochrome system [8].

Light requiring seeds, as some pioneer and early secondary species, need high R:FR radiation for induction of germination, usually found in large gaps and open areas [12]. The relationship between the active form of phytochrome, Pfr, and the final percentage seed germination was demonstrated by Takaki *et al*. [10] in a weed, *Rumex obtusifolius* L., which presents the same characteristic of pioneer species.

Usually research workers use neutral filter such as black plastic net as equivalent of shade light, but those neutral filters decrease the total irradiance without changes in the light spectra. Garcia and Smith [3] proposed the use of insulfilm® like plastic filter to simulate canopy filtered light according to their results of light spectra analyses only. They also indicated the necessity of further experiments with plant developments.

The purpose of the present work was to determine the efficiency of insulfilm® like plastic filter (MSC Specialty Films Inc) to simulate canopy filtered light by analysis of seed germination of *Arctium lappa* L. under laboratorial conditions with comparison with germination tests under natural conditions.

MATERIAL AND METHODS

Five different conditions of light were tested in the present work, according to Table 1. The light spectra of different light sources were obtained with the aid of a LI-1800 spectroradiometer and PC-1800 software (LI-COR, Nebraska, U.S.A.) and the theoretical photoequilibrium of phytochrome determined according to Mancinelli[7].

For germination tests, four replicates of plastic boxes (gerbox) with 30 seeds each of *Arctium lappa* L. were used throughout. For controlled condition tests the gerboxes were put inside wood made boxes (26 x 45cm) with glass lids where plastic filters were put. Three different plastic filter (MSC Specialty Films Inc, San Diego, USA) with different degrees of light filtration were used (Table 1). All experiments were carried out in a temperature controlled room maintained at 25±2°C. The wood made boxes were put under 25W incandescent bulb. For comparison of germination test under natural conditions, four replicates of gerboxes with 30 seeds each were put direct under continuous sun light and *Myrtus communis* L. (Myrtaceae) canopy filtered light. Dark controls were obtained with the use of black gerboxes. The germinated seeds were scored daily under dim green safe light [1] for dark, canopy and plastic filtered light treatments. Seeds with 1mm long roots were considered as germinated. The germinability, germination rate, mean time and synchronization indexes were calculated according to Labouriau and Agudo [5].

RESULTS AND DISCUSSION

The light spectra indicate the similar filtration of low wavelength by both leaves of *Myrtus communis* and by plastic filters (Fig. 1) and low filtration of wavelengths longer than 700nm. The plastic filter 1 maintained the same photoequilibrium of phytochrome of shade light and low radiation (Table 1). Near the same light fluence of shade light can be obtained under laboratory conditions increasing the number of lamps or decreasing the distance of seed from light source. The photoequilibrium of phytochrome maintained by plastic filters 2 and 3 indicates that those lights correspond to low canopy filtration.

Seeds of *Arctium lappa* germinate, specially, under light and shade light inhibits the process. Under direct sun light and under incandescent lamp, seeds presented high percentage germination with 99.2 and 69.2 percentage germination, respectively. Under shade light and plastic filtered lights, low percentage germination was attained. Under plastic filter 1 no germination was observed and under plastic filters 2 and 3, very low germination (Table 2).

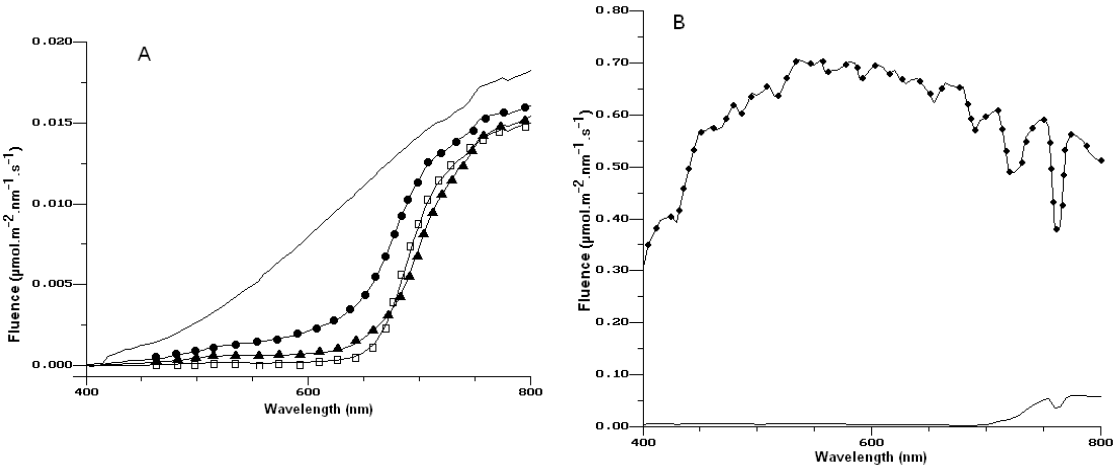

Figure 1 – Light spectra of different conditions used in the experiments. A: incandescent light (–); filter 1 (- -); filter 2 (- ▲ -) and filter 3 (-•-). B: sunlight (-•-) and *Myrtus communis* canopy filtered light (–).

TABLE 1. Characteristics of light sources used for testing the efficiency of plastic filter for simulation of canopy filtered light.

Germination conditions	φ*	R:FR	µmol.m^{-2}.nm^{-1}.s^{-1}	%
Plastic film 1	0.25	0.12	1.32	14.7**
Plastic film 2	0.34	0.19	1.71	19.1**
Plastic film 3	0.49	0.39	3.78	42.2**
Incandescent lamp	0.63	0.75	8.95	100.0
Shade light	0.25	0.12	5.26	2.2***
Sun light	0.71	1.26	238.00	100.0

* Phytochrome photoequilibrium
** Percentage of incandescent lamp light filtration
*** Percentage of sun light filtration

Under laboratory condition, seeds incubated under darkness presented 23.3% germination and when incubated under plastic filtered light inhibition of germination was observed. This indicates that the pre-existing Pfr was removed confirming the efficiency of the plastic filter to remove red radiation. This result demonstrates that FR rich light inhibits germination of seeds of *Arctium lappa.* The same effect was observed under natural conditions, where shade light inhibited germination more than dark incubation. This FR reversion of white light promoted germination was reported by several authors, such as Kendrick [4], Bartley and Frankland [2] and Takaki *et al.* [11]. The inhibitory effect of canopy filtered light on seed germination has been reported by Vázquez-Yanes and Smith [13] in seeds of *Cecropia obtusifolia* and *Piper auritum*.

TABLE 2. Germination percentage and rate, and synchronization index of *Arctium lappa* seeds under different conditions of light.

Germination Conditions	φ* (%)	Germination (%)	Germination rate ($1.day^{-1}$)	Syncronization Index (bits)
Plastic film 1	0,25	-	-	-
Plastic film 2	0,34	1,7 ± 0,8	0,47	0,25
Plastic film 3	0,49	0,8 ± 0,8	0,25	0,02
Incandescent lamp	0,63	69,2 ± 6,3	0,24	1,75
Shade light	0,25	2,5 ± 1,6	0,18	0,25
Sun light	0,71	99,2 ± 0,8	0,19	2,09
Dark - Laboratory	-	23,3 ± 3,6	0,26	1,39
Dark - Canopy	-	8,3 ± 2,2	0,18	0,60

* φ Phytochrome photoequilibrium

Some small differences observed here between laboratory and natural conditions can be due to the different temperatures under laboratory condition, which were maintained under constant 25°C, and under natural conditions, where variation of minimum 11.5°C and maximum 26.3°C was observed during the period. Under controlled condition the germination rate was higher than under natural conditions, possibly due to the temperature effect. Because the low germination under canopy and canopy simulated conditions the germination synchronization indexes did not show evidences of relationship with germinability (Table 2). Nevertheless, same pattern of effect of low R:FR on seed germination has been observed. The germination of seeds of *Arctium lappa* is mediated by Pfr, with threshold in the range of 0.5 to 0.6 of photoequilibrium of phytochrome (Fig. 2) indicating that the germination process is controlled by low fluence response of phytochrome [9]. The results presented here indicate that insulfim like plastic filter can be used efficiently under laboratory condition in combination with incandescent lamps for simulation of canopy filtered light. Only incandescent lamps must be used since fluorescent lamps cannot be used since no radiation is present above 700nm [1] and different degrees of shading can be obtained by the use of plastics with different degree of filtration as presented in the Table1.

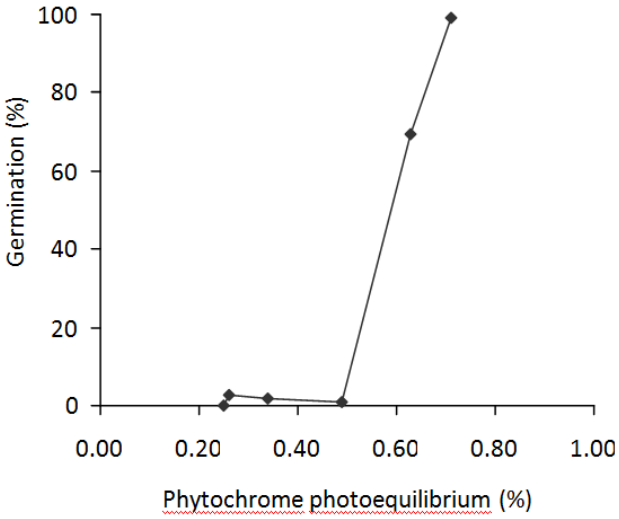

Figure 2 – Relationship between phytochrome photoequilibrium and percentage seeds germination in *Arctium lappa*.

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