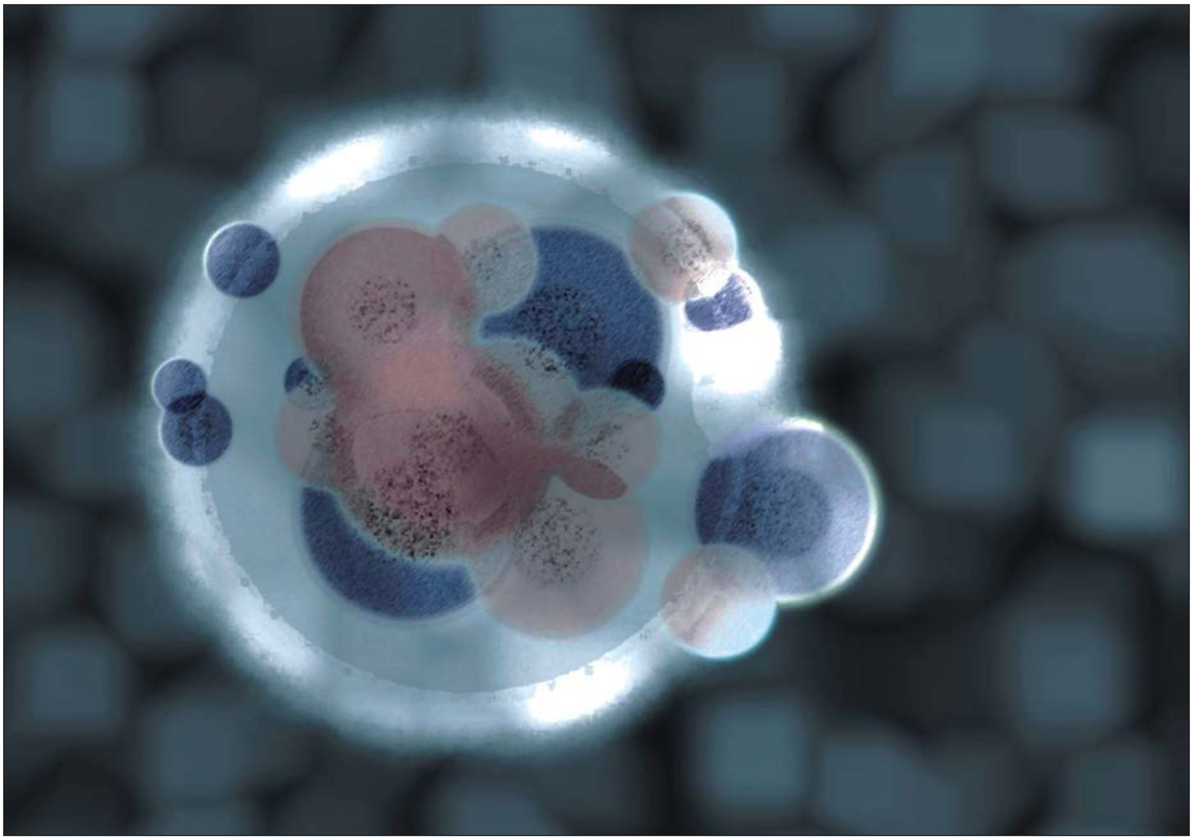

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Germination Rate of St. John's Worth (*Hypericum perforatum* L.) Seeds Exposed to Different Light Intensities and Illumination Periods

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Abstract: In a previous study, we found that *Hypericum perforatum* seeds exhibit both exogenous and endogenous dormancy and the seeds needed light for germination strictly. In this study, the effect of light was studied more deeply. For this, seeds were exposed to different light intensities (0, 600, 1200, 1800 and 2400 lux) for 6, 12, 18 and 24 h a day. According to the results, the effect of light intensities was more evident and 2102.5 lux light intensity with any exposure times evaluated in this study except for 6 h a day was found to be the most suitable treatment for breaking endogenous dormancy.

Key words: *Hypericum perforatum,* germination, light requirement, dormancy

INTRODUCTION

Hypericum perforatum L., also known as St. John's Wort, is a herbaceous perennial belonging to the Hypericaceae family[1]. This plant contains, namely naphthodianthrons and phloroglucinols, biologically active secondary metabolites belonging to at least ten different classes[2]. Hypericin and pseudohypericin, two of components this plant contains, exhibit antiviral[3,4] properties. That is why, it is suggested that *Hypericum perforatum* has a potential in treatment of Acquired Immuno Deficiency Syndrome (AIDS)[5]. In the clinical studies, anti-tumour[6,7] and anti-cancer[8,10] properties of *Hypericum perforatum* were determined. Its use has widely increased on the general market for the herbal treatment of depression, more than doubling its market in the USA and worldwide between 1995 and 1997[11].

There are about 300 *Hypericum* living in mild temperature zone of the world. Turkey is an important center for *Hypericum.* There are 69 *Hypericum* species in Turkey, 24 of which are endemic[12]. *Hypericum perforatum* found in Turkey commonly is worldwide plant economically due to its various secondary metabolite contents. This is evidenced by the fact that the market for *Hypericum perforatum* has exceeded $210 million in U.S.A and $570 million worldwide annually[13] .

Germination is a critical stage in the life cycle of weeds and crop plants and often controls population dynamics, with major practical implications[14]. But, generally germination rate of *Hypericum perforatum* is very low due to seed dormancy[15]. The dormancy is caused by a chemical inhibitor exudate from the capsule[16] and absence of light has a negative effect on germination[17]. This plant prefers to be propagated vegetatively. Both low germination rate and difficulty in cultivating this plant using vegetative plant parts make *Hypericum perforatum* production difficult. Over the past twenty years, dormancy has been widely studied but the regulatory principles behind changes in several types of dormancy remain unclear[18].

In our earlier study, we found that *Hypericum perforatum* seeds exhibit both exogenous and endogenous dormancy. Former could be eliminated by some presoaking treatments but latter was related to the absence of light and seeds depend on light for germination strictly. The aim of the present study was solely to determine the effect of light on germination of *Hypericum perforatum* seeds.

MATERIALS AND METHODS

In the study, the 9 month old seeds obtained from *Hypericum perforatum* plants collected from the mountain pasture named Sisdaği in Trabzon province in North east part of Turkey were used. Seeds were bulked and washed with tap water to remove chemical inhibitor in exudates from capsules. For each application, a total of 300 (3x100) seeds were placed in petri dishes and exposed to 0, 600, 1200, 1800 and 2400 lux white light for a period 6, 12, 18 and 24 h day^{-1}.

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Germinating seeds were counted for 20 days after treatments. Obtained numbers were analysed according to design of split plots using MSTAT packet programme. Differences among treatments were tested by Least Significant Differences (LSD) test[31]. Also, to establish the most suitable light intensity and illumination period for maximum germination hypothetically, regression analyses were performed.

RESULTS AND DISCUSSION

All treatments applied in this study had a significant effect on germination rate ($p<0.01$).

According to the results of variance analysis, the effect of different light intensities on germination rate was significant. As mean of illumination periods, among different light intensities 1200 and 1800 lux gave the highest germination rates found in the same statistical groups with 63.33 and 62.00%, respectively while the lowest germination rate was obtained from control (1%). Regression analysis were performed to determine the degree of the relation between light intensities and germination rates and revealed significant and positive relation (r:0.950*). This positive relation was formulised as $y = 0.2x^2 + 841x + 4.9011$ where y: hypothetical germination rate and x: light intensity (Fig. 1). Owing to the equalisation, it is suggested that the highest germination rate can be obtained from 2102.5 lux light intensity.

As mean of light intensities, all illumination periods evaluated in this study were effective equally for enhancing of germination except for 6 hours a day. Likewise, the presence of light has been reported to be in favour of germination with no dependence of exposure time in *Stellaria media, Cerastium fontanum, Veronica agrestis* and *Taraxacum officinale*[19] and *Typha domingensis*[20].

Apart from each treatment, an interaction ($P<0.01$) between treatments was determined (Fig. 2). In this respect, the highest germination rate was obtained from 1800 and 1200 lux light intensities in the illumination period 18 h a day (77.33 and 76.00%, respectively). Generally all light intensities tested enhanced germination rate in the illumination periods 12, 18 and 24 h a day when compared to 6 h a day and control treatments. These results are in accordance with those of Macchia *et al.*[15], Thompson and Whatley[17], Campbell[16] and Tokur[12] reporting that germination was very low in absence of light in *Hypericum perforatum* seeds. Similar results were also reported by others on *Cyperus odoratus, Gratiola viscidula, Penthorum sedoides* and *Scirpus lineatus*[21], *Triglochin bulbosa* and *T. Striata*[22] and *Typha latifolia*[23].

Table 1: The effects of different light intensities and illumination periods on germination rates of *Hypericum perforatum* seeds

Light intensities (lux)	Germination rates (%) Illumination periods (h day^{-1}) 6	12	18	24	Mean
Control	1.00g	1.00g	1.00g	1.00g	1.00c
600	18.67f	68.00bc	67.33bc	62.67bcd	54.17b
1200	33.33e	70.67bc	76.00a	73.33b	63.33a
1800	33.33e	70.00bc	77.33a	67.33bc	62.00a
2400	22.00f	54.00d	67.33bc	60.67cd	51.00b
Mean	21.67b	52.73a	57.80a	53.00a	

LSD light intensities: 4.881; illumination periods: 4.917; light intensities x illumination periods: 9.761. CV: %11.02 **There is no difference between means marked with the same letter in 1% probability level.

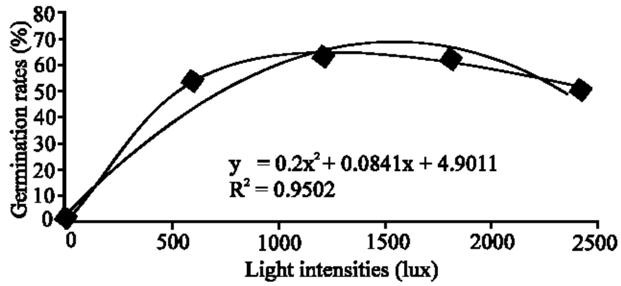

Fig. 1: Light intensities-germination rate relation in *Hypericum perforatum* seeds

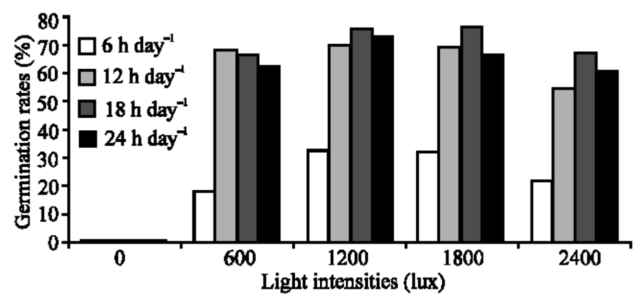

Fig. 2: Light intensities x illumination periods interaction in *Hypericum perforatum* seeds

The effect of light on seed germination is various. Light has no effect on germination of many economically important crops seeds but some of them need light to germinate at the highest level[24]. Light has a regulatory effect on germination and endogenous seed dormancy is usually related to absence of light for some plant species[25]. For examples, *Paulownia tomentosa* and *P. fortenii* seeds had light sensitivity to a large extent. Especially later had an obligatory light requirement for germination and its seeds induced dormancy in darkness, which could be broken by 6 h red light or gibberellic acid[26]. In case of *Halophila engelmannii,* seeds showed an increase in the rate of germination under increased light intensity and had a stoppage of germination after transfer to darkness, indicating a light requirement to break endogenous seed dormancy[27]. *Arabidopsis* *thaliana* seeds passed annually through a pattern of changes in dormancy. This dormancy was broken in summer and re-induced in autumn-winter and this seasonal dormancy patterns were mainly regulated by changes in sensitivity to light[28]. Seeds of *Drosera anglica* needed light to germinate, but light had to be given after temperatures were high enough to be favourable for germination[29]. In *Stenocereus queretaroensis,* seeds germination required light, but became light saturated at a photosynthetic photon flux over 10 days of only 0.15 Mmol m^{-2} s^{-1} [30].

The results of the present study indicate that *Hypericum perforatum* seeds required light to germinate strictly. All light intensities and illumination periods tested had a significant effect on germination, but the effect of light intensities was more evident compared to that of illumination periods. Consequently, 2102.5 lux light intensity with any exposure times evaluated in this study except for 6 h a day was recommended to break endogenous dormancy.

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