Research Article CODEN: IJPRNK IMPACT FACTOR: 4.278 ISSN: 2277-8713
Urkude SE, IJPRBS, 2014; Volume 3(4): 716-723 IJPRBS

INTERNATIONAL JOURNAL OF PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

EFFECT OF LIGHT STRESS ON GERMINATION INDICES OF SPINACH (*SPINACIA OLERACEA* L.)

URKUDE SE, GOGLE DP

Department of Botany, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur- 440033

Accepted Date: 19/08/2014; Published Date: 27/08/2014

Abstract: In the present investigation effect of different colours of light (red, blue, red-blue and silver) on germination indices of Spinach (*Spinacia oleracea* L.) were studied. In this study seven germination indices i.e. Total germination (also known as final germination percentage) (GT), Speed of germination (S), Speed of accumulated germination (AS), Coefficient of the rate of germination (CRG), Mean germination time (MGT), Speed of germination Index (SGI), Vigour index (VI) were calculated from same data to evaluate their effectiveness in data interpretation. Most of the germination indices were found to have highest value in presence of silver colour light. Present investigation supported the hypothesis that data interpretations depends on the choice of germination Index.

Keywords: Light, germination, germination indices, silver, colour.

PAPER-QR CODE

Corresponding Author: MS. SUPRIYA E. URKUDE

Access Online On:

www.ijprbs.com

How to Cite This Article:

Urkude SE, Gogle DP; IJPRBS, 2014; Volume 3(4): 716-723

INTRODUCTION

Germination is an appropriate stage in the life of plants, it is the first step towards survival and is usually controlled by a complex combination of environmental factors. Seed germination and seedling growth has been widely accepted as main parameters to monitor growth responses owing to alternation in environmental factors.

Both the quantity of light and quality of light are environmental cues that signal conditions potentially suitable for seedling establishment and survival (Pons, 2000). Details studies on the effect of light in the germination of light sensitive seeds were made by Flint and Mc. Alister (1935, 1937). Germination of various seeds depends on quality of light was studied by many scientists (Cumming B. G. 1963, Gross K. L. 1985, Roberto L. C. *et al*. 2001, Noble R. E. 2002). In several fields including photobiology, germination bioassays are in wide use to assess the effectiveness of designed treatments. Mostly the maximum percentage germination is considered sufficient for interpretation, which depends only on final results.

In this study seven germination indices i.e. Total germination (also known as final germination percentage) (GT), Speed of germination (S), Speed of accumulated germination (AS), Coefficient of the rate of germination (CRG), Mean germination time (MGT), Speed of germination Index (SGI), Vigour index (VI) were calculated from same data to evaluate their effectiveness in data interpretation. Objectives of the present study were to calculate different germination indices from the same data in order to make comparisons between each of them and to evaluate better ways of using these indices in order to improve the precision in seed germination bioassays.

MATERIAL AND METHOD:

Seeds of Spinach (*Spinacia oleracea* L.) were selected for present investigation. In the present investigation, different coloured papers were used for giving transmission light treatment to the seeds. Two types of coloured papers were use in present investigation. i. e., cellophane Papers (red, blue, red blue) and reflective Metalized Film or Mylar. The transmission spectra of these colours were obtained using spectrophotometer (Urkude Supriya E. *et al.* 2013). For the determination of germination indices various coloured boxes were made using coloured cellophane papers wrapping around cardboard box. Germination % was determined by petriplate method. Seeds were germinated in petri dishes containing filter paper soaked in glass-distilled water. Sufficient amount of distilled water was added so that it maintained constant moisture. Then 100 seeds were kept in petriplates. All the boxes were kept in such a way that they maintain pure and equal amount of light. Then seeds were kept for germination and petriplates were regularly observed

for moisture content. Germination of seeds was recorded for 5- 7 days after every 24 hrs. and seeds were considered germinated when the radical became visible. It has been found difficult to interpret data from seed germination bioassays to make conclusions about the most colour treatment that can be selected for present investigation. To overcome this dilemma in the present investigation has used different indices to show light effects on germination. Germination indices i.e. Total germination (also known as final germination percentage) (GT), Speed of germination(S), Speed of accumulated germination (AS),Coefficient of the rate of germination (CRG), Mean germination time (MGT), Speed of germination Index (SGI), Vigor index (VI) were calculated as described in Table 1.

Length of seedling (root, shoot and total length), fresh and dry weight of seedling (root, shoot and total weight) and moisture content of seedling were also determined.

Table 1. Formulaes to Calculate Germination Indices:

Sr. No.	Germination index	Formula	References
1	Total germination (Final germination percentage) (GT)	GT = [NT x 100] / N NT: proportion of germinated seeds in each treatment for the final measurement N: Number of seeds used in bioassay	Widely used
2	Speed of germination (S)	S = (N1 x 1) + (N2 – N1) x 1/2 + (N3 – N2) x 1/3 + ……. (Nn– Nn-1) x 1/n N1, N2, N3, Nn-1, Nn: Proportion of germinated seeds observed at first, second, third …… (n – 1), (n) days or hours.	Bradbeer (1988), Wardle *et al.* (1991)
3	Speed of Accumulated germination (AS)	AS = [N1/1 + N2/2 + N3/3 ……. + Nn/n] N1, N2, N3, Nn: Cumulative number of seeds which germinate on time 1, 2, 3, ……., N	Bradbeer (1988), Wardle *et al.* (1991), Haugland and Brandsaeter (1996)
4	Coefficient of the rate of germination (CRG)	CRG = [N1 + N2 + N3 + ….. + Nn] X 100 / (N1 x T1) + (N2 x T2) + (N3 x T3) + …… (Nn x Tn) N1: number of germinated seeds at time T1 N2: number of germinated seeds at time T2 Nn: number of germinated seeds at time Tn	Bewley and Black (1985)

5	Mean germination time(MGT)	MGT= N1 + (N2-N1)+(N3-N2)+……(Nn-1 -Nn) / T1+T2+T3+…….Tn N1, N2, N3…..Nn are no. of germinated seedson T1,T2,T3….Tn days	Nicholas and Heydecker (1968)
6	Speed of germination Index(SGI)	SGI =(7 x N1)+(6 x N2)+ (5 x N3)+ (4 x N4) + (3 x N5) + (2 x N6) + (1 x N7) N1, N2, N3…..N7 are no. of germinated seedson 1^{st},2^{nd} ,3^{rd} ……7^{th} days resp.	Carley and Watson (1968)
7	Vigor index (VI)	(VI) = [seedling length (cm) × germination percentage]	Abdul – Baki and Anderson (1973)

RESULTS AND DISCUSSIONS:

The transmission spectra of blue, red and silver papers are shown in Figure. From fig., red and blue cellophane paper transmits red and blue light along with UV-A light. Red light intensity was more than blue light. Silver paper transmits low intensity visible light along with UV-B light.

From table (2 and 3) germination percentage was highest in silver colour treatment And lowest in red blue colour treatment. Speed of germination was found to be highest in silver followed by control and lowest in red colour treatment. Speed of accumulated germination was highest in control and lowest in red colour treatment. Coefficient of rate of germination was highest in silver and lowest in blue-silver colour treatment. Mean germination time were found to be highest in the silver followed by blue and lowest in red-blue colour treatment. Speed of germination index was highest in control and lowest in red colour treatment.

Length of 10 days old seedling of Spinach (*Spinacia oleracea* L.) were found to be highest in silver colour treatment followed by red-silver and lowest in red-blue colour treatment. Fresh weight of seedling was found to be greater in red-silver treatment and lower in red-blue colour treatment. Dry weight of seedling was found to be more in silver and red-silver colour treatment and lowest in the red-blue colour treatment. Vigour index was found to be highest in red colour treatment and lowest in red-blue colour treatment. Whereas, moisture content was found to be highest in red-silver and blue-silver colour treatment and less in red-blue colour treatment.

From the above results it get cleared that germination were more in presence of silver light which transmits mostly UV-B light. Therefore it must be said that in Spinach (*Spinacia oleracea* L.) seeds germination were take place by UV-B photoreceptor mechanism. K.L. Gross (1985) was investigated that in *Verbascum thapsus* germination of blue light was more followed by control and less in red colour light and Spinach (*Spinacia oleracea* L.) shows similar results.

Noble R. E. (2002) the effects of UV-irradiation was studied on the germination of kale, cabbage, radish and agave seeds. In case of Spinach (*Spinacia oleracea* L.), speed of germination

Fig. : Absorbance (Transmission) spectra of Red, Blue Cellophane and Mylar (Silver paper).

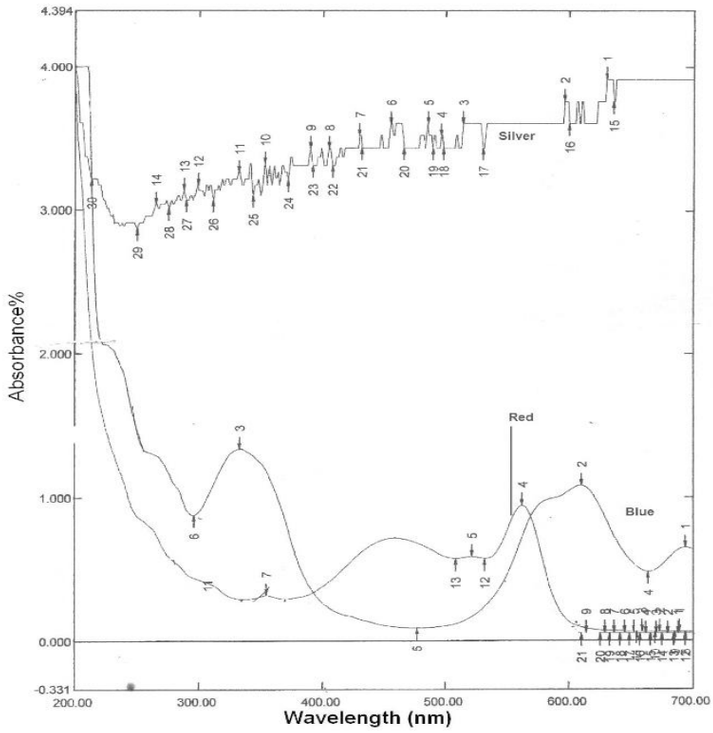

Table 2: Effect of different colours of light on Germination Indices of Spinach (*Spinacia oleracea* L.).

Colour treatment	GT (%)	S	AS	CRG	MGT	SGI
Control	51.333±4.163^{bc}	9.634±0.391^{e}	30.258±0.618^{f}	20.696±0.172^{cd}	0.916±0.075^{bc}	403.333±5.508^{f}
Red	35.333±2.309^{a}	5.776±0.256^{a}	17.094±0.570^{a}	20.072±0.223^{b}	0.632±0.040^{a}	223.333±7.234^{a}
Blue	52.000±2.000^{bc}	9.058±0.351^{de}	27.334±0.833^{e}	20.371±0.069^{bc}	0.929±0.036^{bc}	358.667±9.866^{e}
Red-Blue	33.333±1.155^{a}	6.942±0.555^{b}	20.513±0.909^{b}	20.683±0.105^{cd}	0.595±0.021^{a}	273.333±8.021^{b}
Silver	57.333±2.309^{c}	11.287±0.270^{f}	30.044±0.630^{f}	20.753±0.076^{d}	1.024±0.041^{c}	359.667±6.807^{e}
Red-Silver	47.333±1.155^{b}	8.469±0.302^{cd}	25.269±0.665^{d}	20.305±0.113^{b}	0.845±0.021^{b}	326.000±7.937^{d}
Blue-Silver	52.000±2.000^{bc}	7.781±0.259^{bc}	23.064±0.658^{c}	19.131±0.096^{a}	0.928±0.037^{bc}	297.667±10.599^{c}

Values represented as mean of ten replicates ± SD; for each column, different lowercase letters indicate significantly different at P< 0.05, as measured by 2-sided Tuckey's HSD between different colour treatments.

GT(%) - Total germination % , S- Speed of germination, AS-Speed of accumulated germination, CRG - Coefficient of the rate of germination, MGT- Mean germination time, SGI-Speed of germination Index.

Colour treatment	Length of seedling (cm)			Fresh weight of seedling (gm)			Dry weight of seedling (gm)			Vigour Index	Moisture content
	Shoot	Root	Total	Shoot	Root	Total	Shoot	Root	Total		
Control	4.690±0.075^{f}	0.997±0.015^{a}	5.687±0.091^{a}	0.170±0.008^{c}	0.036±0.004^{c}	0.205±0.011^{c}	0.008±0.001^{c}	0.001±0.000^{a}	0.009±0.001^{ab}	292.147±28.090^{a}	0.197±0.011^{c}
Red	2.440±0.040^{b}	2.342±0.473^{a}	4.782±0.508^{a}	0.174±0.007^{c}	0.027±0.002^{abc}	0.202±0.006^{c}	0.006±0.001^{b}	0.001±0.000^{a}	0.007±0.001^{a}	974.547±1508.351^{a}	0.195±0.006^{c}
Blue	3.033±0.049^{c}	0.770±0.020^{a}	3.803±0.055^{a}	0.152±0.004^{b}	0.024±0.003^{ab}	0.176±0.006^{b}	0.006±0.000^{bc}	0.001±0.000^{a}	0.007±0.000^{a}	197.813±9.536^{a}	0.169±0.006^{b}
Red-Blue	1.923±0.021^{a}	0.937±0.015^{a}	2.860±0.035^{a}	0.128±0.007^{a}	0.019±0.003^{a}	0.147±0.010^{a}	0.003±0.001^{a}	0.004±0.005^{a}	0.006±0.004^{a}	95.360±4.434^{a}	0.141±0.013^{a}
Silver	4.803±0.025^{f}	2.107±0.021^{a}	6.910±0.046^{a}	0.195±0.004^{d}	0.025±0.004^{ab}	0.220±0.008^{cd}	0.013±0.001^{de}	0.002±0.000^{a}	0.015±0.001^{c}	396.240±18.517^{a}	0.205±0.008^{c}
Red-Silver	4.223±0.032^{e}	1.930±0.036^{a}	6.153±0.068^{a}	0.197±0.005^{d}	0.033±0.005^{bc}	0.230±0.009^{d}	0.014±0.000^{d}	0.001±0.000^{a}	0.015±0.000^{c}	291.293±9.567^{a}	0.215±0.009^{c}
Blue-Silver	4.087±0.015^{d}	1.840±0.046^{a}	5.927±0.060^{a}	0.197±0.005^{d}	0.031±0.005^{bc}	0.228±0.002^{d}	0.011±0.001^{e}	0.001±0.000^{a}	0.012±0.001^{bc}	308.220±13.391^{a}	0.215±0.002^{c}

Values represented as mean of ten replicates ± SD; for each column, different lowercase letters indicate significantly different at P< 0.05, as measured by 2-sided Tuckey's HSD between different colour treatments.

VI-Vigor index

was found to be decreased except silver colour treatment which reflected UV-B radiation increased speed of germination while growth of seddling were decreased in all colour treatment comparing with control except treatments containing silver colour light having UV-B radiation.

Speed of germination considers the number of germinated seeds between two exposure times, where as accumulated germination involves the cumulative number of germinated seeds at each exposure time. In case of Spinach (*Spinacia oleracea* L.), S and AS were significantly different whereas, GT, CRG, MGT and SGI were slightly differ. Length of seedling and vigour index are not significantly differ but fresh and dry weight, moisture content were slightly differ.

Above Results supported the hypothesis that data interpretations depends on the choice of germination index and also that one index might not be suitable for precise description of phototropic effects on the germination process. Comparison of different indices may provide better justification. This will contribute in making photobiology a more precise science.

CONCLUSION:

Present investigation showed that most of the germination indices were found to have highest values in presence of silver colour light but it showed that data interpretations depends on the

choice of germination index and species and also that one index might not be suitable for precise description of phototropic effects on the germination process. Comparison of different indices may provide better justification. Analysis based on germination indices could be a useful tool for describing the effect of light to germination process This will contribute in making photobiology a more precise science.

REFERENCES:

1. Pons TL. Seed responses to light. In: Fenner M, ed. Seeds: the ecology of regeneration in plant communities. New York, NY: CAB International. 2000.

2. Flint, L. H. and Mc E. D. Alister. Wavelength of radiation in the visible spectrum inhibiting the germination of light sesetive lettuce seed. Smithson, Misc. Collns. 1935; 94 (1).

3. Flint, L. H. and E. D. McAlister. Wavelength of radiation in the visible spectrum promoting the germination of the light. sensitive lettuce seed. Smithson. Misc. Collns. 1937; 96 (1).

4. Cumming, B. G. The dependence of germination on photoperiod, light quality and temperature in chenopodium spp. Can J. Bot. 1963; 41**:** 901-926.

5. Gross, K. L. Effects of irradiance and spectral quality on the germination of *Verbascum thapsus* L. and *Oenothera biennis* L. seeds. New Phytologist. 1985 ; 101 (3): 531-541

6. Roberto, Lindig-Cisneros and Joy Zedler. Effect of light on seed germination in *Phalaris arundinacea* L. (reed canary grass): Plant Ecology . 2001; 155 : 75-78.

7. Noble, R. E. Effects of UV-irradiation on seed germination. Sci Total Environ. 2002 ; 1;299 (1-3) : 173-176.

8. Urkude Supriya E., Gogle D. P.: Effect of light stress on germination indices of leafy vegetables .Bionano Frontier 2013;7(1) : 87-92.

9. Bradbeer, J. W. *Seed Dormancy and Germination,* pp.146. Blackie and Son, Glasgow. 1988.

10. Wardle, D. A., M. Ahmad and K. S. Nicholson. Allelopathic influence of nodding thistle (*Carduus nutans* L.) seeds on germination and redicle growth of pasture plants. *New Zealand* J. Agric. Res. 1991 ; 34 : 18591.

11. Haugland, E. and L. O. Brandsaeter. Experiments on bioassay sensitivity in the study of allelopathy. J. Chemical Ecol. 1996; 22 : 184559.

12. Bewley, J. D. and M. Black. *Seeds: Physiology of development and Germination.* 367. Plenum Press, New York. 1985.

13. Nicholas, M. A. and W. Heydecker. Two approaches to the study of germination data. Pro. Int. Seed Test Assoc. 1968; 33: 531-540.

14. Carley, H. E. and R. D. Watson. Effect of various aqueous extracts upon seed germination. Bot. Gaz. 1968; 129: 57-62.

15. Abdul A. A. Baki and J. D Anderson. Crop science. 1973; 13: 630-6.