AUCTORES
Globalize your Research

Journal of Biotechnology and Bioprocessing

Kanwal Iqba, Anam Iqbal

Open Access

Research Article

Effect of different light on wheat (Triticum aestivum L) growth and role of phytochrome

Sana Zahra[b], Afroz Rais[b], Atiya yousf[b], Ghanva younis[b], Hafiza Amina Amin[b], Ghazala Shaeen[a], Kanwal Iqbal[b]*, and Anam Iqbal[a]*.

[a] Department of Chemistry, University of Baluchistan Quetta 87300, Pakistan.

[b] Department of Chemistry, Sardar Bahadur Khan Women's, University Quetta 87300Pakistan.

Corresponding Author: **Anam Iqbal**, Department of Chemistry, University of Baluchistan Quetta 87300, Pakistan.

Kanwal Iqbal, Department of Chemistry, Sardar Bahadur Khan Women's, University Quetta 87300, Pakistan.

Received date: July 18 2020; **Accepted date:** July 25, 2020; **Published date:** August 10, 2020

Citation: Sana Zahrab, Afroz Raisb, Atiya yousfb, Ghanva younisb, Hafiza Amina Aminb, Ghazala Shaeena, Kanwal Iqbalb*, and Anam Iqbala; Effect of different light on wheat (Triticum aestivum L) growth and role of phytochrome; J, Biotechnology and Bioprocessing. 1(1); DOI:10.31579/2766-2314/001

Abstract

Among the various naturally occurring abiotic factors regulating plant development, different types of light play an important role in them. Photosynthesis, photoperiodism, and photo morphogenesis. In this trial the effects of different colors of light on (seed) germination, phytochrome conversion, length of seedling, biomass production in wheat varieties Shalkot and Tandojam. The rate of germination data indicates white 96%, Red 100%, far-red 95%, Blue 95%, and dark 64%, in Shalkot. In Tandojam rate of germination 94% White, 93% red, 82% far red,

92% blue, and 50% dark, were observed. Root and shoot length were higher in Shalkot under white light. Difference between dry and fresh weight in Shalkot under white, red, far-red, blue, dark, 1.66g, 0.94g, 0.98g, 0.97g, 0.6g, respectively. In Tandojam difference between dry and fresh weight observed under white, red, far-red, blue, dark, 1.48g, 0.92g, 0.70g, 0.97g, 0.4g respectively. By using bioinformatics tools identified some light-harvesting genes in wheat (*Triticum aestivum*) by using model plant *Arabidopsis thaliana*. The identified light-harvesting genes include

cl02879, cl25816, cl33336, cl31857, cl28913.

Keywords: light, growth, phytochrome, germination, light-harvesting gene

Introduction

Light plays several important roles in the life of several microorganisms, animals, and plants. The behaviour of plant metabolism in response to different biotic and abiotic factors which cause damage, such as UV radiation, unfavourable temperature, drought, salinity, is regulated by a system of phytochrome [1-3]. In light the plant photoreceptor playing a major role, Photoreceptor contains a phytochrome [4-5]. A large range of physiological developments from the germination of the seed to flowering and the fruiting is controlled by the system of phytochrome [6-8]. Plants go through from two different programs of development: photo morphogenesis in the existence of light and skotomorphogenesis in the in-existence of light. The plant that is grown in dark showed phenotype etiolated such as apical hooks, long hypocotyls, and cotyledons are yellow and closed. In comparison, the plant which is grown in light exhibits phenotype of photo morphogenesis distinguished by green open and enlarge cotyledons, and small hypocotyls. Light also regulates other developmental and growth program by managing shade avoidance, the flowering of photoperiodic and directional growth [9].

On the display of red light phytochrome completely change forms from inactive phytochrome red (660nm) to active phytochrome far-red (730nm) [9]. Red light absorption by phytochrome red transforms the protein to the phytochrome far-red that is far-red absorbing form. Far-red light absorption by phytochrome far-red turns the confirmation again to phytochrome red. Therefore to the first estimation, phytochrome maybe regards as convertible light-activated red/far-red switches of molecular [9-10]. Far-red and red light has a great impact on the growth extension, it is mean that it affects the stem length, plant height, and also the left size [11], [12, 13]. Blue light participates in a large number of processes of the plant such as the opening of stomata, phototropism, the photosynthetic function of the leaf, and photo morphogenesis [14, 15].

Wheat is a widely grown crop around the world for its high nutritive value [16]. The demand for wheat is more in comparison to other crops. Wheat is mostly cultivated in temperate areas [17]. The effect of light quality on the growth and morphology of wheat has been studied [18, 19]. In the present study, we used the different light type that regulates the phytochrome, developmental rate of wheat with valuable information about light-harvesting candidate genes which work in light stress.

Materials and Methods

Two wheat verities (Shalkot, Tandojam) seeds were collected from the seed certification department Islamabad, Pakistan. Selected seeds were sterilized by Hydrogen peroxide (10%) for five minutes, then washed three times with distilled water and air dry for 30 minutes [20]. Seeds were imbibed in 100 ml distilled water for 12 hours. For the germination test, the 10 viable seeds were placed on a double layer of Whatman filter paper in a 9cm diameter petri dish. Initial protuberances in the wheat seeds were showed the germination of the seed [21]. Different light (white, red, far-red, blue, dark conditions) were used for the germination of sterilized seeds [22].

1. Dark and white light condition

For dark treatment, the sterilized seeds petri dishes were cover with aluminum foil and placed into the cotton box (provide the darkness). For white light treatment, the petri dishes were kept in the germinator under the white light fluorescent (Philips TLD18W/54-764). Allow them to germinate for seven days [23].

2. Red, far-red and blue light condition

For red and blue light Plexiglas filter (3mm thick) was used. While for far-red light arranged a red filter between two blue Plexiglas filters. And passed tube light (Philips TLD18W/54-765) in Plexiglas filters [24].

3. Gene collection

The gene that expressed during light stress condition were taken from the model plant *Arabidopsis thaliana* by using NCBI database, to identify the light-harvesting gene in wheat (*Triticum aestivium)* [25]. In model plant identification of computational gene aid in gene annotation by using Nr, to develop the relation between wheat (*Triticum aestivium)* and Arabidopsis thaliana.

4. Blast

A similarity sequence was obtained by using the blast. The coding region of the sequence of the nucleotide of *Arabidopsis thaliana* was submitted to BLAST, that organism we selected that have maximum query cover and identity [26].

5. Open reading frame

FASTA sequence of wheat (*Triticum aestivium)* and *Arabidopsis thaliana* were submitted to ORF-finder. Which gives the coding sequence of the nucleotide of the model plant and reference plant.

6. Conserve domain

By using the data of gene in conserve domain we found wheat (*Triticum aestivium)* and *Arabidopsis thaliana* families' information these families were present in both model plant and reference plant [27].

7. Statistical analysis

The data were analyzed with analysis of variance (ANOVA) using the statistical package Genstat 9.2 (VSN International Ltd., Hemel Hempstead, Hertfordshire, UK). The mean values were compared and separated based on Fisher's least significant difference (LSD) test.

Result

1. Seed germination of wheat varieties under various light conditions at the optimal temperature (20ºC)

Two varieties of wheat Shalkot and Tandojam were observing under various light conditions (white light, red light, far-red light, blue light, and dark). The germination was started from 1st day in all light conditions. In shallots maximum germination observed under red light (100%), as compared to white light (96.66%), Far-red light (95.71%), and Blue light (95.23%) the minimum germination rate were observed in dark condition (64.29%) (**Table 1**).

The maximum germination in Tandojam was observed under white light (94.76%) followed by red light (93.33%), far-red light (82.38%), blue light (92.85%) respectively. Minimum (50%) germination was observed in dark condition (**Table 1).**

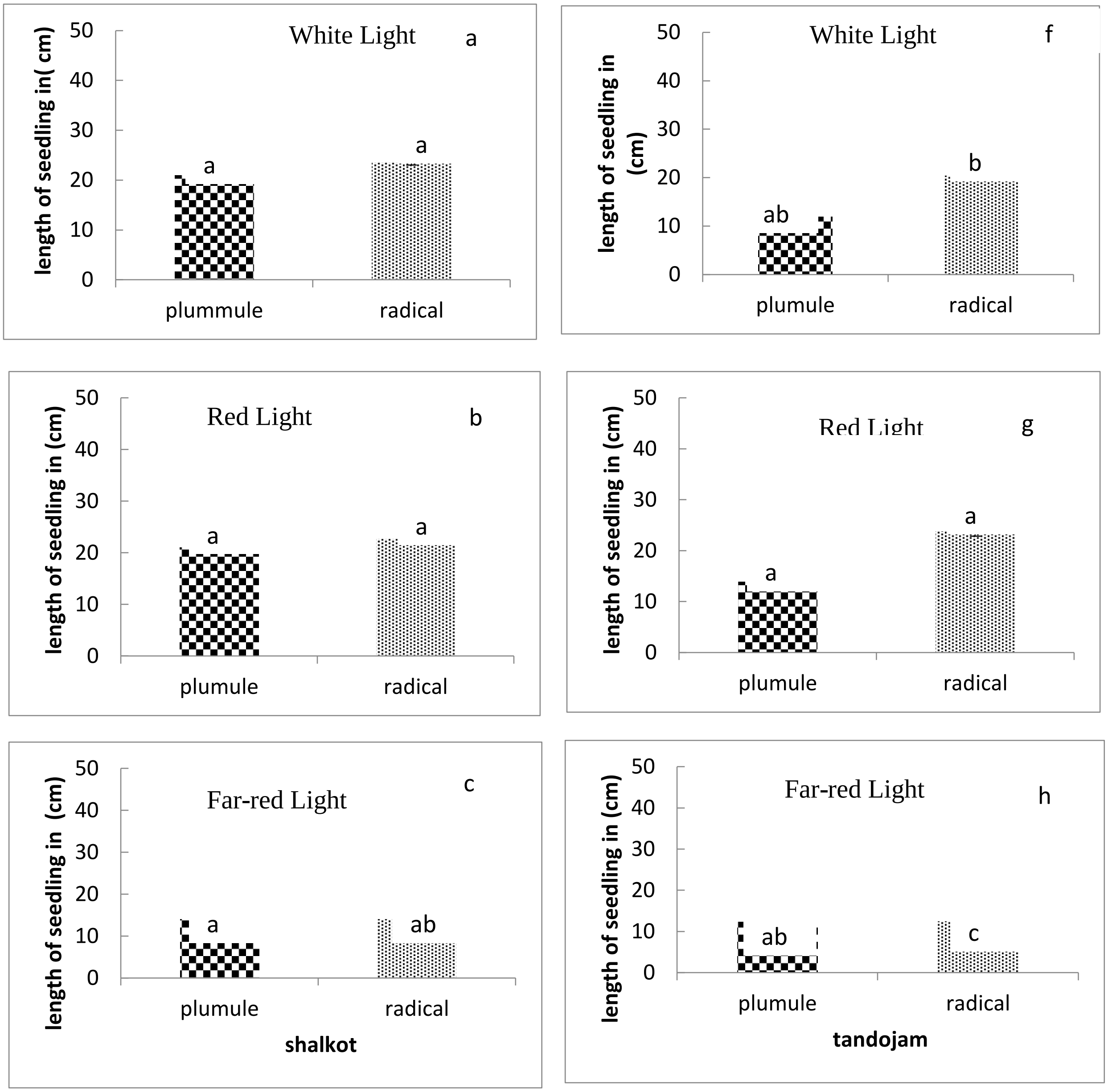
Treatments	White light	Red light	Far–red light	Blue light	Dark
Shalkot (germination %)	$96.66^{ab}\pm0.36$	$100^{a}\pm0$	$95.71^{ab}\pm0.41$	$95.23^{ab}\pm1.37$	$64.29^{ab}\pm1.04$
Tandojam (germination %)	$94.76^{a}\pm0.96$	$93.33^{a}\pm0.96$	$82.38^{b}\pm3.73$	$92.85^{a}\pm0.82$	$50^{c}\pm.40$

Values are means of three replicates ± SE and values bearing different letters in the same column are no-significantly different from each other

Table 1. The percentage of seeds germination of Shalkot and Tandojam under different light conditions.

2. Effect of various light on seedling length at the optimal temperature (20ºC)

Seedling length of Shalkot plumule (20.95) and radical (23.45cm) was more efficient under white light, as compared to Tandojam seedling, plumule (11.9cm) and radical (20.38cm) (**Fig.1**a, f). Under red treatment, the Shalkot seedling lengths plumule (21cm), radical (22.61cm) were shown. Similarly in Tandojam, plumule (13.82cm), radicals (23.77cm) (**Fig.1** b, g). The maximum length of plumule (14.3cm) and radical (14.3cm) were show under far-red light in Shalkot as compare to Tandojam the length of plumule (12.25cm) and radical (12.4cm) were found (**Fig.1** c, h). The plumule (14.45cm) and radical (14.82cm) of Shalkot under blue light much longer as of Tandojam, plumule (10.74cm), and radical (12.71cm) (**Fig.1** d, i). The dark condition did not show the vital role in the length of the seedling. In Shalkot the minimum growth length of plumule (8.75cm) and radical (10.17cm) was observed under dark condition, On the other hand, and length of plumule (4.4cm) and radical (5.18cm) were found in Tandojam seedling under dark condition (**Fig. 1**.e, j).



3. Effects of biomass under various light conditions at the optimal temperature (20ºC)

Different lights (white light, red light, far-red light, blue light, and dark) effects on wheat varieties (Shalkot, Sanober) biomass. The maximum biomass was showed in shalkot under white1.66g, followed by red 0.94g, far-red 0.98g, blue 0.97g, dark, 0.6g, respectively. Similar effects were observed in Tandojam under white1.48, red0.92g, far-red 0.70g, blue 0.97g, dark 0.4g respectively (**Table. 2**).

Treatment	Shalkot (Biomass g)	Tandojam(Biomass g)
White light	1.66^{a}±0.04	1.48 ^{a} ±0.08
Red light	0.94^{b}±0.05	0.92 ^{b} ±0.04
Far-red light	0.98^{b}±0.03	0.70 ^{b} ±0.03
Blue light	0.97^{b}±0.08	0.97 ^{ab} ±0.05
Dark	0.6^{b}±0.02	0.4 ^{a} ±0.02

Table 2. Biomass effects in shalkot and tandojam under different light conditions.

Values are means of three replicates ± SE and values bearing different letters in the same column are no significantly different from each other.

4. Comparative study of wheat with Arabidopsis thaliana

Identify the light-harvesting genes of reference plant wheat (*Triticum aestivium)* and five genes of sample plant *Arabidopsis thaliana* from NCBI (National center for biotechnology information) databases, such as ORF (open frame readings), BLAST (basic local alignment search tool), and conserve domain were used to identify the gene ID, accession number and query cover. Through ORF finder entire open reading frame of a selected sequence is determined. The basic local alignment search tool (BLAST) was used to disclose the query cover of reference plant wheat (*Triticum aestivum)* and model plant *Arabidopsis thaliana*. Selected 5 genes that had maximum query cover (99%, 99%, 75%, 72%, and 62%). NCBI tool conserves domain database was used to reveal the gene families. The superfamily was present in both plants *Arabidopsis thaliana* and wheat (*Triticum aestivum)*, like Chloroa_b-bind, KAR9, ftsH, PLN02281, and SIMIBI (**Table. 3**).

S.No	Gene ID	Accession No	Query cover	Families of domain	*Arabidopsis thaliana* model plant	Wheat (*Triticum*)
1	LOC9300399 351914	cl02879	99%	Chloroa_b-bind	Present	Present
2	CAB3 330637	cl25816	99	KAR9	Present	present
3	VAR2 360212	cl33336	75%	ftsH	present	Present
4	CH1 358733	cl31857	72%	PLN02281	present	present
5	CPSRP54 355789	cl28913	62%	SIMIBI	Present	Present

Table 3. Comparative study of Triticum asestivium with Arabidopsis thaliana.

Discussion

Interactions among stress action and plant growth are intricate as plant corresponds with, many environmental factors. As the most significant widely distributed stress of the environment, light is best-known to have an important impact on wheat. In our study white light and red were showed maximum results with an aspect of germination percentage, length of seedling, and biomass. A similar result was observed [28]. The ecological important attributed to the response of light in these families is that the light serves as an indicator of soil depth, permitting higher germination of seed on the surface than seeds bury in soil [29-30]. Plants have considerably extensive signaling mechanisms of light, with photoreceptors consecrate to various wavelengths in the spectrum of light and interactions among these photoreceptors and their pathways of signal transduction. Availability of light on the growth of root gonna be the basic effect of availability of differential sugar to roots this is because, in shoot presence of photosynthesis, there is significant proof for more complex signaling effects of various light environments aspects [31].

The light receptor group performs blue light deduction. They act immoderately in promoting elongation of the primary root, the opening of stomata in Arabidopsis, and induction of flowering circadian clock [32]. A similar result was observed in the case of root elongation in our study.

In the case of a far-red light study, our result was showed the positive aspects. Through Phytochromes, the Signaling of r/fr light was used by plants that regulate shade avoidance, germination, and senescence [33. The red light absorbed by inactive phytochrome red that result in photoconversion into a form of active phytochrome far-red then to inactivate it absorbs far-red light. To detect light connected phytochromobilin is utilized by phytochrome and light signal is transferred which goes through from convertible conformation variations [34, 35].

By using the bioinformatics tool harvesting genes were expressed under different light stress. Our results based on five harvesting genes of wheat compared with the model plants *Arabidopsis*. It has been shown that they may also be involved in response to different light conditions. Wheat can react to under the active metabolism of various phytohormones, e.g., SA, ABA, and JA that are proposed to be intricate in acclimation of light [36].

Conclusion

In conclusion, it is clear that different types of lights such as (red-far red, blue, white and dark) regulates the various physiological, anatomy and cell signaling pathways. Different light effects on seed germination and plant growth. Phytorome is most important protein which directly affect by reversible form of red to far-red light .Under light stress (different light intensity and quality of light) expresses different genes. There are still many query are unclear at molecular level. Especially cell signaling and gene. But Bioinformatics study play promoting role regarding light stress gene family members which are active under different type of light stress.

References

1. Carvalho, R. F., Campos, M. L., and Azevedo, R. A. (2013). The role of phytochromes in stress tolerance. In *Salt Stress in Plants* (pp. 283-299). Springer, New York, NY.
2. Kreslavski, V. D., Kosobryukhov, A. A., Schmitt, F. J., Semenova, G. A., Shirshikova, G. N., et al (2017). Photochemical activity and the structure of chloroplasts in Arabidopsis thaliana L. mutants deficient in phytochrome A and B. *Protoplasma*. *254*: 1283-1293.
3. Galvão, V. C., & Fankhauser, C. (2015). Sensing the light environment in plants: photoreceptors and early signaling steps. *Curr. Opin. Neurobiol*. *34*: 46-53.

4. Su, J., Liu, B., Liao, J., Yang, Z., Lin, C., et al (2017). Coordination of cryptochrome and phytochrome signals in the regulation of plant light responses. *Agron*. *7*: 25.
5. Kreslavski, V. D., Los, D. A., Schmitt, F., Zharmukhamedov, S. K., Kuznetsov, V. V., & Allakhverdiev, S. I. (2018). The impact of the phytochromes on photosynthetic processes. Biochimica E\t Biophysica Acta (BBA). *J Bioenerg*. 1859: 400-408.
6. Quail, P. H. (2010). Phytochromes. *Curr. Biol*. *20*: 504-507.
7. Carvalho, R. F., Moda, L. R., Silva, G. P., Gavassi, M. A., & Prado, R. M. (2016). Nutrition in tomato ('Solanum lycopersicum'L) as affected by light: Revealing a new role of phytochrome A. *Aust. J. Crop Sci. 10*: 331.
8. Kong, S. G., &Okajima, K. (2016). Diverse photoreceptors and light responses in plants. *J.Plant. Res*. *129*: 111-114.
9. Pham, V. N., Kathare, P. K., & Huq, E. (2018). Phytochromes and phytochrome interacting factors. *Plant Physiol*. *176*: 1025-1038.
10. Leivar, P., & Quail, P. H. (2011). PIFs: pivotal components in a cellular signaling hub. *Trends Plant Sci*. *16*: 19-28.
11. Kasperbauer, M. J. (1987). Far-red light reflection from green leaves and effects on phytochrome-mediated assimilate partitioning under field conditions. *Plant. physiol*. *85*: 350-354.
12. Singh, D., Basu, C., Meinhardt-Wollweber, M., & Roth, B. (2015). LEDs for energy efficient greenhouse lighting. *Renew. Sust. Energ. Rev*. *49*: 139-147.
13. Yoshida, H., Mizuta, D., Fukuda, N., Hikosaka, S., &Goto, E. (2016). Effects of varying light quality from single-peak blue and red light-emitting diodes during nursery period on flowering, photosynthesis, growth, and fruit yield of everbearing strawberry. *Plant Biotechnol*. *33*: 267-276.
14. Whitelam, G. C., & Halliday, K. J. (Eds.). (2007). *Light and plant development*. Blackwell Pub.
15. Hogewoning, S. W., Trouwborst, G., Maljaars, H., Poorter, H., van Ieperen, W., &Harbinson, J. (2010). Blue light dose–responses of leaf photosynthesis, morphology, and chemical composition of Cucumis sativus grown under different combinations of red and blue light. *J. Exp. Bot. 61*: 3107-3117.
16. Oyewole, C. (2016). *The wheat crop* (pp. 1-16). Technical report, Department of Crop production, Faculty of Agriculture, Kogi state University.
17. Ibrahim, M., Hassan, A., Iqbal, M., &Valeem, E. E. (2008). Response of wheat growth and yield to various levels of compost and organic manure. *Pak. J. Bot*. *40*: 2135-2141.
18. Barnes, c., & Bugbee, B. (1992). Morphological responses of wheat to blue light. *J. Plant Physiol.* 139: 339-342.
19. Goins, G. D., Yorio, N. C., sanwo, M. M., & Brown, c. s. (1997). photomorphogenesis, photosynthesis, and seed yield of wheat plants grown under red light-emitting diodes (LEDs) with and without supplemental blue lighting. *J. Exp. Bot*. 48: 1407-1413.
20. Daud, N. H., Jayaraman, S., & Mohamed, R. (2012). Methods Paper: An improved surface sterilization technique for introducing leaf, nodal and seed explants of Aquilaria malaccensis from field sources into tissue culture. *As. Pac.J Mol.Biol. & Biotech*. *2*:55-58.
21. Moshatati, A., & Gharineh, M. H. (2012). Effect of grain weight on germination and seed vigor of wheat. *Int. j. agric. crop sci*. *4*: 458-460.
22. Barrero, J. M., Jacobsen, J. V., Talbot, M. J., White, R. G., Swain, S. M., Garvin, D. F., &Gubler, F. (2012). Grain dormancy and light quality effects on germination in the model grass Brachypodiumdistachyon. *New. Phytol*. *193*: 376-386.
23. Smith, M. A., BELL, D. T., & Loneragan, W. A. (1999). Comparative seed germination ecology of Austrostipa compressa and Ehrharta calycina (Poaceae) in a Western Australian Banksia woodland. *Aust J Ecol*. *24*: 35-42.
24. Pezzani, F., & Montaña, C. (2006). Inter-and intraspecific variation in the germination response to light quality and scarification in grasses growing in two-phase mosaics of the Chihuahuan Desert. *Ann. Bot*. *97*: 1063-1071.
25. Jenuth, J. P. (2000). The NCBI. In *Bioinformatics Methods and Protocols* (pp. 301-312). Humana Press, Totowa, NJ.
26. Altschul, S. F., Gish, W., Miller, W., Myers, E. W., & Lipman, D. J. (1990). Basic local alignment search tool. *J. Mol. Biol*. *215*: 403-410.
27. Marchler-Bauer, A., Lu, S., Anderson, J. B., Chitsaz, F., Derbyshire, M. K., DeWeese-Scott, C. & Gwadz, M. (2010). CDD: a Conserved Domain Database for the functional annotation of proteins. *Nucleic Acids Res*. *39*: 225-229.
28. Flores, J., González-Salvatierra, C., & Jurado, E. (2016). Effect of light on seed germination and seedling shape of succulent species from Mexico. *J.P.E*. *9*: 174-179.
29. Kivilaan, A, Bandurski, R. S. (1981). The one hundred-year period for Dr. Beal's seed viability experiment. *Am. J. Bot*. *68*: 1290-1292.
30. Lamsal, A., Devkota, M. P., Shrestha, D. S., Joshi, S., Shrestha, A. (2019). Seed germination ecology of Ageratum houstonianum: A major invasive weed in Nepal. *PloS one*. *14*: e0225430.
31. Vanlerberghe, G. C., Dahal, K., Alber, N. A., & Chadee, A. (2020). Photosynthesis, respiration and growth: A carbon and energy balancing act for alternative oxidase. *Mitochondrion*
32. Gavassi, M. A., Monteiro, C. C., Campos, M. L., Melo, H. C., & Carvalho, R. F. (2017). Phytochromes are key regulators of abiotic stress responses in tomato *Sci. Hortic*. *222*: 126-135.
33. Franklin, K. A., & Quail, P. H. (2010). Phytochrome functions in Arabidopsis development. *J. Exp. Bot. 61*: 11-24.
34. Chen, M., & Chory, J. (2011). Phytochrome signaling mechanisms and the control of plant development. *Trends .Cell. Biol*. *21*: 664-671.
35. Xu, X., Paik, I., Zhu, L., & Huq, E. (2015). Illuminating progress in phytochrome-mediated light signaling pathways. *Trends Plant Sci*. *20*: 641-650.
36. Van Gelderen, K., Kang, C., & Pierik, R. (2018). Light signaling, root development, and plasticity. *Plant Physiol*. *176*: 1049-1060.