Journal of Research in Weed Science

Journal homepage: www.jrweedsci.com

Original Research

Seed germination and seedling growth of some crops and weed seeds under different environmental conditions

Mallik Baby Babita Das [a,*], B.D. Acharya [a], M. Saquib [b], M.K. Chettri [a]

a Botany Department, Amrit Campus, Lainchaur, Tribhuvan University, Kathmandu, Nepal.

b Department of Biological Sciences, University of Maiduguri, Maiduguri (Borno State), Nigeria.

ARTICLE INFORMATION

Received: 15 November 2019

Revised: 22 January 2020

Accepted: 11 February 2020

Available online: 13 February 2020

DOI: 10.26655/JRWEEDSCI.2020.3.8

KEYWORDS

Germination

Moisture

Temperature

Weeds

ABSTRACT

Seed germination of some crops (*Brassica campestris* and *Triticum aestivum*) and weed seeds (*Ageratum conyzoides*, *Bidens pilosa*, *Cyperus rotundus* and *Galinsoga parviflora*) was studied under different environmental conditions like moisture (concentrations 3, 6, 9, 12, 15ml), temperature (5, 10, 15, 20 and 25˚C), pH (value 4, 5, 6, 7, 8 and 9) and light (normal, red, yellow, blue, green and dark color). For the crops too much lower or higher moisture was not favorable for germination and growth. Experiments under different moisture conditions showed that *C. rotundus* and *G. parviflora* do not require more moisture to germinate and grow. Seed germination of both crops enhanced insignificantly at 15 to 20˚C treatments. Seed germination of all weed seeds was insignificantly high at 10 to 15˚C. The percentage of seed germination of both crops increased significantly in normal and green light. Seed germination of *A. conyzoides*, *C. rotundus* and *G. parviflora* was insignificantly different in normal, red, yellow and green light. Germination of all weed seeds was completely inhibited by blue and dark light. The shoot and root length of weed *A. conyzoides* was found to be significantly high (P=0.05) in yellow light treatment, but in *B. pilosa*, it was high in red and green light. Similarly in *C. rotundus*, shoot and root length were high in normal light but in of *G. parviflora* it was high in green light treatment. Seed germination and seedling growth were higher in pH5-7 in most cases.

Introduction

Weeds are native and non-native plants growing in unwanted place. It spread very fast and are competitive in natures; it competes for water, soil, nutrients, light, and space so it reduced the crop quality and yield in agricultural ecosystem (McErlich and Boydston, 2013). The weed competes in different ways; fast-growing weeds compete for light while low growing weed competes for water and nutrients with the crops (Schonbeck, 2013). Weeds possess special ability in growth, which

Corresponding author, email: babitamallik@yahoo.com (Mallik Baby Babita Das).

permits adaptation in various conditions and very fast growth that give them advantages over crop (Paudel et al. 2017). Weeds reduce the crop yield either by reducing the amount of harvestable product or crop actually harvested In Nepal, weeds are an unending problem of loss in crop yield in agricultural land (Paudel et al. 2017).

Among the different weeds, majority belongs to family Asteraceae. *Ageratum conyzoides* of the family Asteraceae is present in Nepal not as an invasive weed (Kaur et al. 2012; Waterhouse 1993; Ranjit and Bhattrai, 1988) but as the worst weed. It is common weed germinated in agricultural fields in tropical and subtropical regions (Feng et al. 2002; GISD, 2016). *Bidens pilosa* is a noxious weed of family Asteraceae of the tropical region (Bartolome, 2013). The plant can control photoperiod depends on the time of year. The flowering period is between 10 and 14 short days. Gibberellic acid, chlormequat, and 2,4-D had no effect on *B. pilosa* in a long-day (Kirszenzaft and Felippe, 1978). *B. pilosa* reproduced vegetatively (Huang et al. 2012), which might partially dominate and colonized habitats.

Cyperus rotundus is a perennial plant belonging to the family Cyperaceae and found in tropical and subtropical regions (Sayed et al. 2007; Xu et al. 2009). The flowers of *Cyperus* are many but produce a small number of seeds. The main source of propagation of *Cyperus* is not by only seeds but also by the rhizome, tuber and basal bulb. *Cyperus rotundus* is highly competitor for different crops (Baloch et al. 2015). It is the common weeds of wheat and mustard field in Nepal. *Galinsoga parviflora* occurs in different types of soil but it easily grows in damp and rich soil (Warwick and Sweet, 1983). The peripheral achenes of *G. parviflora* live in soil as a seed bank and remained viable for a longer time than the central achenes (Kucewicz et al. 2014; Espinosa et al. 2003). In Nepal, there are 370 weeds in the field of *Triticum aestivum* L. in which 69 sps. of weeds belongs to Asteraceae family, Poaceae (52 spp.), Leguminosae (25 spp.), Polygonaceae (19 spp.), Caryophyllaceae (18 spp.), Scrophulariaceae (17 spp.), Euphorbiaceae and Lamiaceae (14 spp. each), Brassicaceae and Cyperaceae (13 spp.), and Solanaceae (11 spp. each) were the dominant families, which accounted for 71.35% of the total weeds. The most commonly reported weeds of wheat in Nepal are *Ageratum conyzoides*, *Bidens pilosa*, *Cyperus rotundus* and *Galinsoga parviflora* (Dangol, 2013). In Nepal the wheat yield have also been reported to decrease up to 50% by weeds and sometimes even more when weed population and density were higher (Ranjit et al. 2009). In the case of the Chitwan area of Nepal, Dangol and Choudhary (1994) have reported 30 weed species from wheat fields. Ranjit (2002) and Shah (2013) had reported the broadleaf weeds are the major problems in the agricultural field. Sapkota et al. (2010) reported a total of 44 weed species representing 18 families from wheat fields of Khokana and a new weed *Vicia* sp. was reported along with other dominant weed like *Chenopodium album*, *Polygonum plebeium* and *Spergula arvensis*.

Wheat is considered as the most important cereal crop after rice in Nepal. Of the total cultivated area in the country (2,968,000 ha), rice is cultivated in 1,544,990 ha and wheat in 669,014 ha. Eighty four per cent of the wheat cultivation area falls under rice-wheat rotational system (Singh and Paroda, 1994). Many weeds have been identified in the wheat crop weeds like *Phalaris minor*, *Chenopodium album*, *Cyperus rotundus*, *Convolvulus arvensis*, *Cnicus arvensis, Parthenium hysterophorus*, *Chromolena adenophora*, *Ageratum conyzoides* and *Galinsoga parviflora* have recently become the most consistently troublesome weed in the winter crop field. In Nepal, yield loss in wheat ranged from 15% to 70% (Ranjit, 1997). Mustard is the third important oilseed crop in the world after soybean (*Glycine max*) and palm oil. The global production of mustard and its oil is around 38–42 and 12–14 mt, respectively (Patel et al. 2017). Weeds cause an alarming decline in crop production ranging from 15-30% to a total failure in rapeseed-mustard yield (Patel et al. 2017; Shekhawat et al. 2012). In mustard field interference of weeds causes yield losses up to 45%. A variety of weed affects these crops but the extent of damage in terms of yield and resources is location specific (Singh et al. 2013). The effective management of weed seeds distribution can be understood by knowing the weed seed germination ecology. Seed sizes and the environmental factor of weed seeds affected the associated plants (Tanveer et al. 2013). The seed germination, morphology (Powell 2010), seed sizes (Kidson and westoby, 2000) are the important feature for seed establishment. Some plants grow in lower pH level and some at higher pH level. The pH is not the sign of fertility but affects the uptake of fertilizer nutrients. So, it affects the germination of seeds (Ward, 2015).

The various environmental conditions like temperature, moisture light and pH affects the germination and growth of both crops and weeds (Auld and Ooi, 2009; Rawal et al. 2015a,b; Shrestha et al. 2017). Some species are not affected by favorable condition until a certain factor breaks the dormancy (Monoroe, 2018; Reece et al. 2011). Germination of plants occurs at a particular time of the year at different habitat (Cochrane et al. 2011; Shrestha et al. 2017). Some weed seeds are sensitive to light for germination and will emerge when they are close to the soil surface (Milberg et al. 2000). Hence to understand the environmental conditions which favor germination of winter crop like mustard and wheat and also on some weeds associated with them. The experiments was conducted in the laboratory related with different environmental conditions which helps to manage the seed germination and seedling growth of some associated weeds of the agricultural field (*B. campestris* and *T. aestivum*).

Materials and Methods

Collection of crop and weed seeds

Two crop seeds (*B. campestris* and *T. aestivum*) were bought from agroshop in Kathmandu, Nepal. Mature weed seeds of *A. conyzoides, B. pilosa, C. rotundus* and *G. parviflora* were collected from selected sites of Kirtipur (Chobhar, Dhapla, Near Tribhuvan University, Machhegaon and Chhugaon) and Bhaktapur (Lokanthali, Gathhaghar, Balkot, Sano Thimi and Thimi) in the month of March and April 2014. These are the common weeds in both crop fields.

Seed germination

Weed seeds (*A. conyzoides*, *B. pilosa, C. rotundus* and *G. parviflora*) and the crop seeds of *B. campestris* and *T. aestivum* were treated with 2% Sodium hypochlorite for 2 minutes separately for surface sterilization. Then the seeds were washed with distilled water thoroughly. The sterilized petri dishes were lined with single Whatman No. 1 filter paper and moistened with 5ml distilled water. The crops (*B. campestris, T. aestivum)* and weeds *(A. conyzoides*, *B. pilosa, C. rotundus and G. parviflora*) seeds of uniform size were selected and ten seeds of each species were kept in sterilized petri dishes.

Environmental conditions

a) Temperature: Five replications of petri dishes containing 10 sterilized seeds of selected crops and weed seeds were kept in incubator maintaining different temperatures level (5, 10, 15, 20, 25˚C) separately for 10 days.

b) Moisture: Five replications of petri dishes containing 10 sterilized seeds of selected crops and weed seeds were kept in filter paper soaked with 3, 6, 9,12 and 15ml distilled water for 10 days.

c) Light: The petri dishes containing 10 sterilized seeds of crops and weeds were covered by cellophane papers of different colors like red, yellow, blue, green and black polyethylene (for dark condition). For control, the petri dishes containing crop and weed seeds were grown in filter paper soaked with 5ml distilled water in normal light without any covering. All these experiments were conducted under normal room temperature (20^{o}C) with five replications. The moisture level in the petri dish was maintained by adding distilled water as required. Seed germination and seedling growth were recorded after 10 days.

d) pH: To study the effect of pH on seed germination of two winter crops (*B. campestris* and *T. aestivum*) and some weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*), five replications of ten seeds were kept in Whatmen No. 1 paper in petri plates. The solutions with different pH values of 5, 6, 7, 8 and 9 were prepared using 0.1 HCl and 0.1 KOH. The seeds were kept in room temperature (20^{o}C). The weeds were found in winter crops fields (Wheat and Mustard). The experiment was conducted on the month of November.

Results and Discussion

Moisture

The effects of different amount of moisture on seed germination, shoot and root length are given in Figure 1. Seed germination of winter crops *B. campestris* and *T. aestivum* reduction were highest at 6 ml and 9 ml treatment, respectively, and significant reduction was at 15ml treatment. Seed germination of weed seeds like *A. conyzoides* and *B. pilosa* were mostly high at 3 ml and 6 ml treatments. Seed germination of *C. rotundus* and *G. parviflora* were insignificantly different in all treatments. No seed germination was observed at 15ml treatment in both weeds (Figure 1a).

Shoot and root length of both germinated crop seeds were significantly high at 6 ml treatment. Similarly, shoot and root length of germinated seeds of *A. conyzoides* and *B. Pilosa* were significantly high at 6 ml treatment but in case of *C. rotundus* and *G. parviflora*, it was significantly high at 3ml treatments. This indicated that *C. rotundus* and *G. parviflora* do not require more moisture to germinate and grow (Figure 1 b and c).

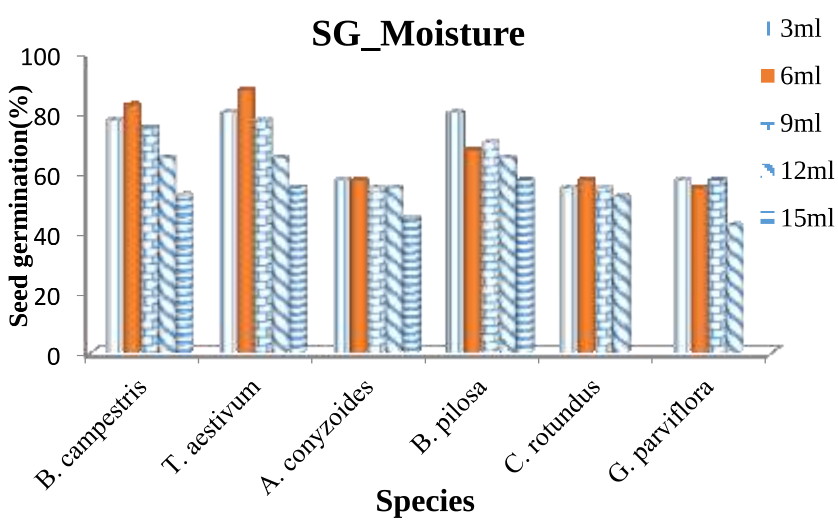

Figure 1a. Seed germination (SG %) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different moisture conditions (3, 6, 9, 12 and 15 ml).

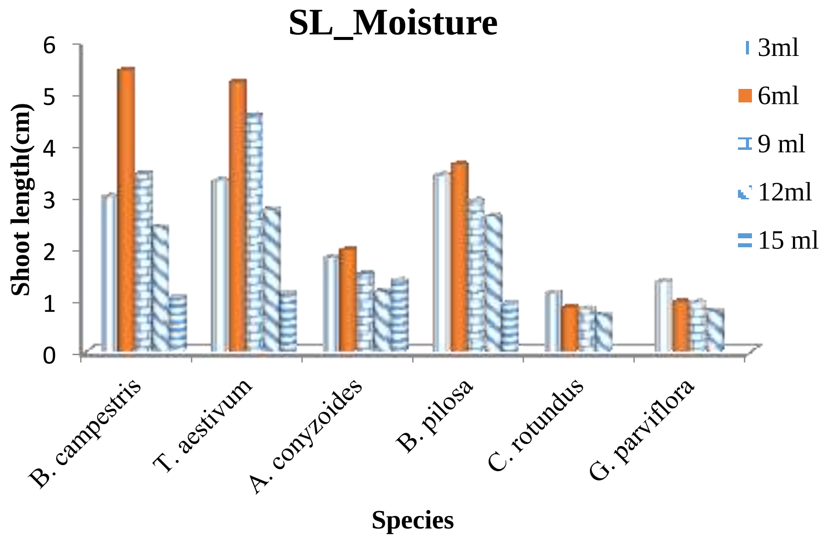

Figure 1b. Shoot length (SL cm) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different moisture conditions (3, 6, 9, 12 and 15 ml).

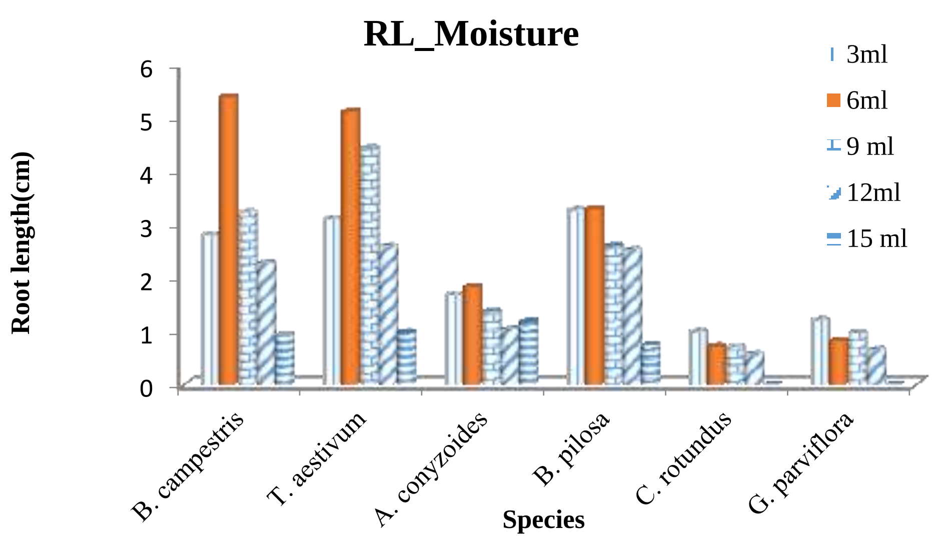

Figure 1c. Root length (RL cm) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different moisture conditions (3, 6, 9, 12 and 15 ml).

Seed germination in both the crops (*B. campestris* and *T. aestivum*) was highest in 6ml and 9ml treatments and reduced significantly in 15ml treatment. Similar results were also observed for *Phaseolus vulgaris*, *Spinacea oleracea* (Orphanos and Heydecker, 1968) and *Beta vulgaris* (Heydecker et al. 1971). Similarly, seed germination of *Cyperus* and *Galinsoga* completely inhibited with 15ml treatment. This may be due to formation of a water film over the seed's surface and free water in the substrate block the hilum opening (Carpenter, 1991) as seeds were completely immersed in water with 15ml treatment. The water film might have act as a barrier to osmotic diffusion and result reduced the germination, shoot and root length in both the crops. At high moisture content, seeds also lost viability (Oliviera and Valio, 1992). Tubers and seeds of *C. rotundus* were stay dormant to survive in dry seasons. These species are able to multiply rapidly through tubers (Coleman et al. 2018).

Temperature

Seed germination of crops (*B. campestris* and *T. aestivum*) and selected weed seeds are at different temperatures given resulting in Figure 2 a. Seed germination of both crops enhanced insignificantly at 15 to 20˚C treatments. Seed germination of all weed seeds was insignificantly high at 10 to 15˚C (Figure 2 a).

Shoot and root length of germinated both crop seeds were found to be significantly high at 15 to 20˚C. Shoot and root length of germinated weed seeds also increased significantly high at 15 to 20˚C, except in *B.pilosa*, where it increased at 10 to 15˚C. This indicated that low temperature enhances the growth *B. pilosa* more than other weeds (Figure 2 b and c).

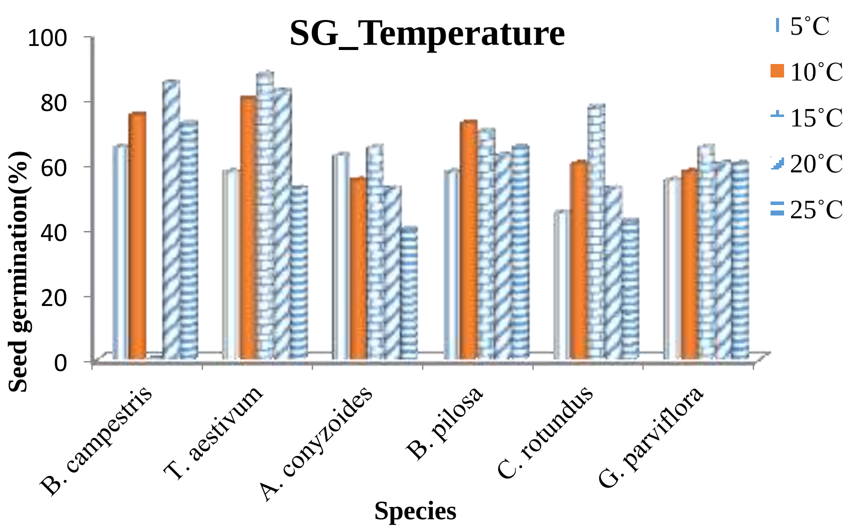

Figure 2a. Seed germination (SG %) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different temperature conditions (5, 10, 15, 20 and 25˚C).

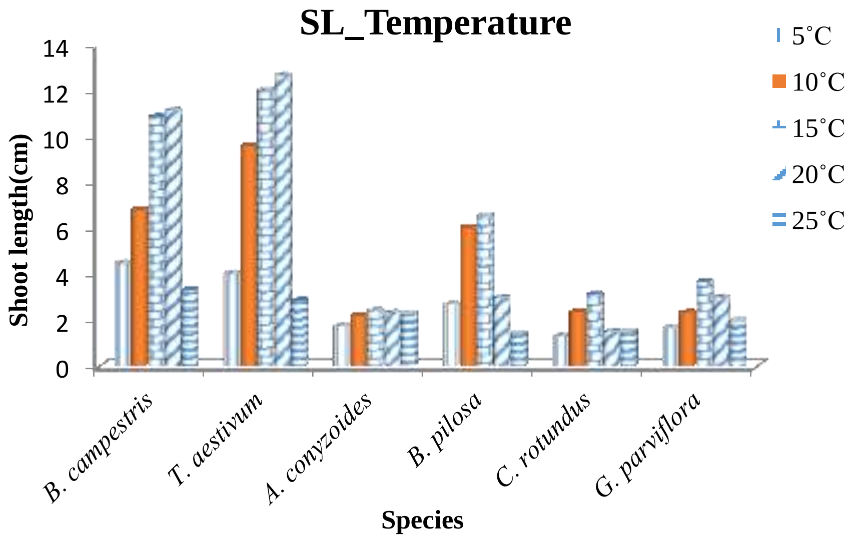

Figure 2b. Shoot length (SL cm) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*)on different temperatures (5, 10, 15, 20 and 25˚C).

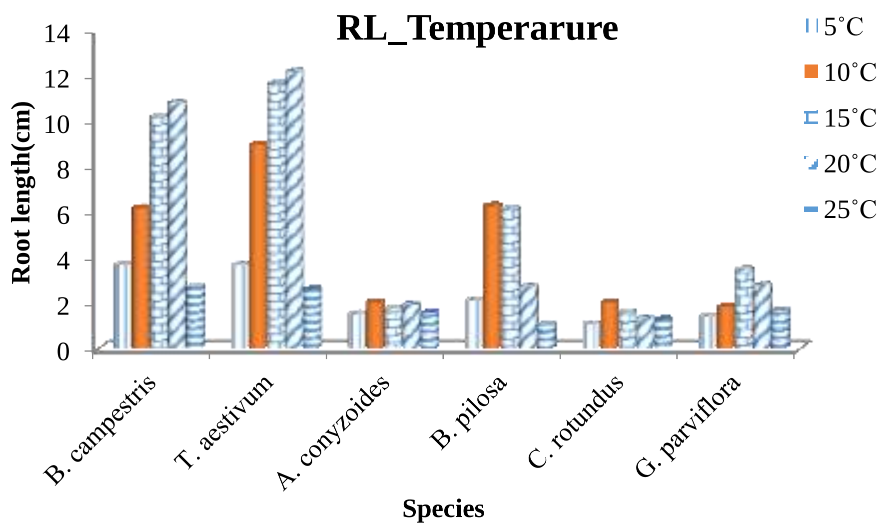

Figure 2c. Root length (RL cm) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different temperatures (5, 10, 15, 20 and 25˚C).

Germination of seeds and seedling growth depends on favorable environment conditions. Temperature is one of the most important environmental conditions for seed germination and seedling growth (Fenner and Thompson, 2005). Germination of two winter crops (*B. campestris* and *T. aestivum*) was higher at 15-20˚ C in the present study and reduced at 25˚C indicating that the high temperature is not favorable for them to germinate. All tested weeds (*A. conyzoides*, *B. pilosa*, *C.*

rotundus and *G. parviflora*) were germinated at all the treatments of temperature, indicating their tolerance to a wide range of temperature. These weeds are quite common in winter as well as summer crops and (Thapa 2001; Zhao et al. 2016; Assang et al. 2011) had been reported that high temperature availability will increase atmospheric water demand which could lead to additional water stress from increased water pressure deficits. In the present study, the winter crops *B. campestris* and *T. aestivum* showed reduced germination with high temperature which may be due to water stress.

Light

The percentage of seed germination of both crops *B. campestris* and *T. aestivum* increased significantly (P=0.05) in normal and green light. Seed germination of *A. conyzoides*, *C. rotundus* and *G. parviflora* was insignificantly different in normal, red, yellow and green light. The seed germination of *B. pilosa* increased slightly at normal light than in all other colored light (Figure 3 a). The shoot and root length of both the crops *B. campestris* and *T. aestivum* was increased significantly (P=0.05) at normal light. The shoot and root length of weed *A. conyzoides* was found to be significantly high (P=0.05) in yellow color light treatment, but in *B. pilosa,* it was high in red and green light. Similarly in *C. rotundus*, shoot and Root length were high in normal light but in of *G. parviflora* it was high in green light treatment (Figure 3 b and c).

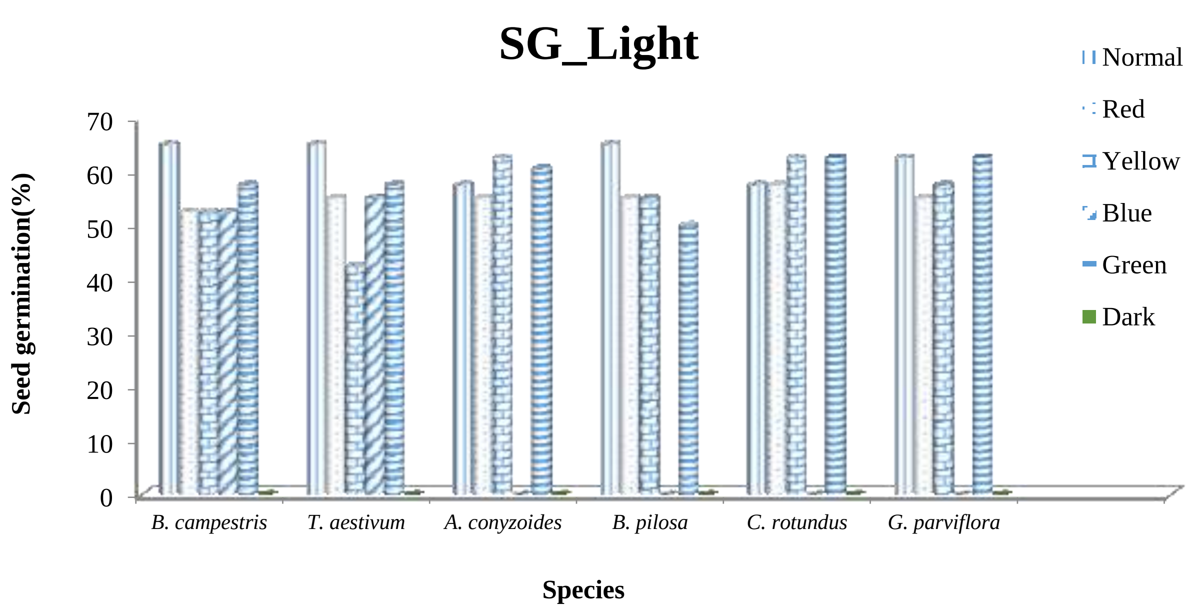

Figure 3a. Seed germination (SG %) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different colors of light (normal, red, yellow, blue, green and dark).

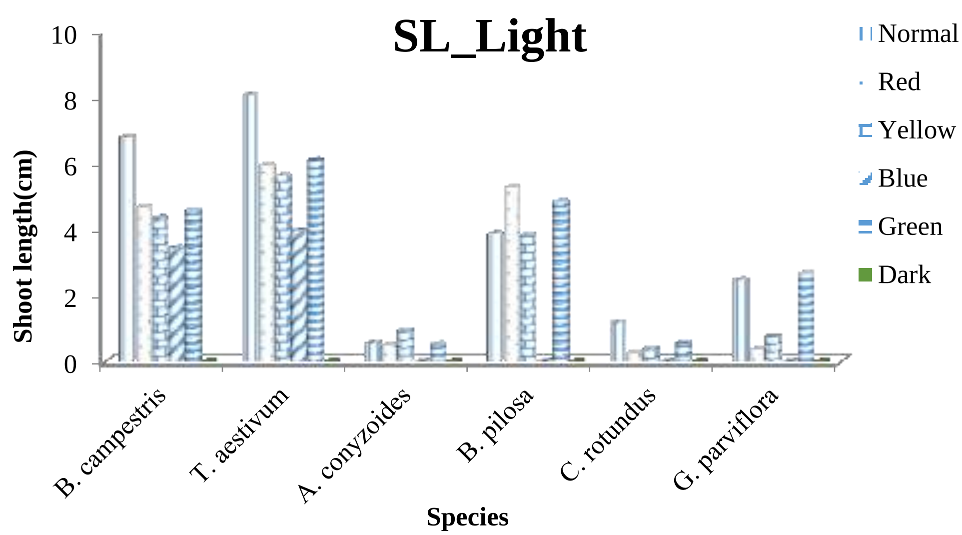

Figure 3b. Shoot length (SL cm) of two crops (*B. campestris* and *T. aestivum*) and four weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different colors of light (normal, red, yellow, blue, green and dark).

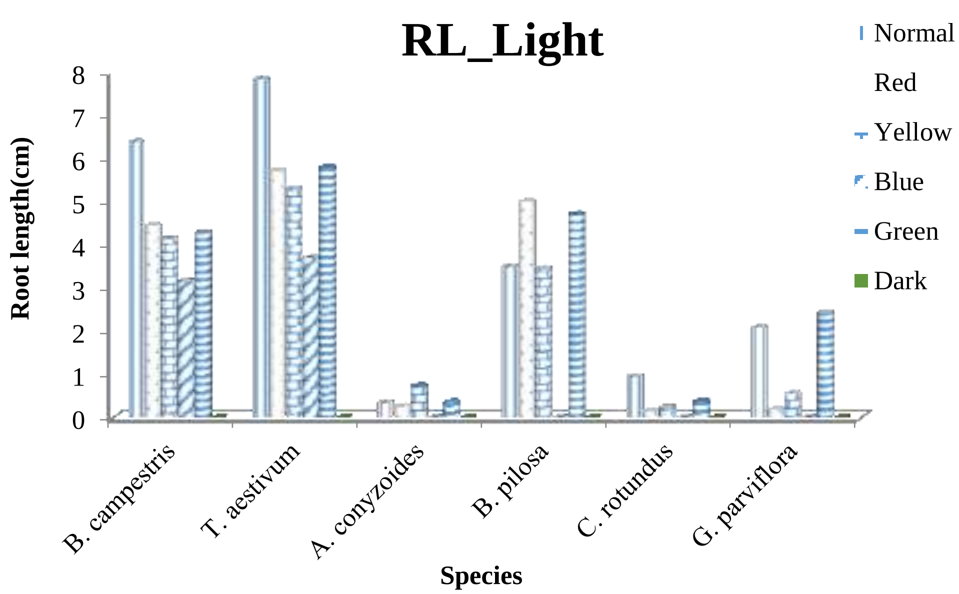

Figure 3c. Root length (RL cm) of crops (*B. campestris* and *T. aestivum*) and weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different colors of light (normal, red, yellow, blue, green and dark).

Light is one of the important factors for seed germination and seedling growth. The seeds of both crops germinated in all light conditions (even in blue light), but weed seeds could not germinate in blue light. Seeds that require light for germination are usually small (Cann, 2014). Milberg et al. (2000) suggested that light response and seed mass must have coevolved as an adaptive features to ensure seed germination of small seeded species only when close to the soil surface. On the other hand, a phylogenetic component of light promoted germination - regardless of seed size- has also been suggested as phytochromes are well known to mediate light promoted germination. Phytochromes are also known to increase the amount of bioactive gibberellins in seeds (Cann, 2014) and this might have initiated germination process. In the present study, both the crops and weed could not germinate in dark. This show that light is one of the environmental conditions that are required for seeds germination and seedling growths of tested seeds because phytochrome play a significant role in determining the time of germination (Kołodziejek and Patykowski, 2015). In seed germination experiment conducted for 131 taxa of Campanulaceae by Koutsovoulou et al. (2014), found that the seed germination was higher in light in comparison to darkness.

The wheat and mustard seeds germinated in blue light, more or less similar to red, yellow or green light. In wheat (Xu et al. 2009) and in *Brassica napus* (Chatterjee et al. 2006) Cryptochromes/ a blue/ultraviolet-A light sensing photoreceptors have been reported. In wheat two cryptochrome genes - TaCRY1 and TaCRY2 have been identified, and which might be involved in the abscisic acid signaling pathway in addition to their role in primary blue light signal transduction (Xu et al. 2009). Possibly in *Brassica campestries* also the cryptochrome act as photoreceptor to initiate seed germination in blue light. Mostly, seed germination was high in red light and low or no germination in blue light, which is in consistence with general observation that the red light promotes germination while blue light inhibits it (Batty et al. 1989). All the selected weeds could not germinate in blue light. Blue light is usually referred to as radiation with wavelength between 400 and 500nm. Different phytochromes activates at different wavelengths of light. Under wavelength 700 nm both phytochrome A and B are active. However, phytochrome A functions optimally around 600 to 690 nm and at wavelength larger than 700nm it becomes inactivated while phytochrome B remains active (Phytochrome, 2013). As blue light ranges from 400-500nm, both phytochromes might have remained inactive and this might have inhibited the germination in the selected weeds.

Besides this, the seed germination in wheat and mustard might be due to the higher concentration of endogenous gibberellins than the abscisic acid. The gibberellin synthesis occurs when the seeds absorb moisture, this hormone diffuse across the endosperm to the aleurone layer (in case of wheat), which then produce and release the hydrolytic enzyme require to digest the stored food of endosperm. The stored starch was breakdown by enzymes to its smaller unit glucose, protein to amino acid etc. which are then translocated to the embryo. The embryo used them for the growth of radical and plumule during germination (Bhattrai, 2007).

pH

Seed germination of both crops (*B. campestris* and *T. aestivum*) and two weeds (*A. conyzoides* and *B. pilosa*) were high significantly at pH 7. The germination of *C. rotundus* seed was insignificantly high at pH 6 whereas in *G. parviflora*; it was significantly high at pH 6 treatment (Figure 4 a). Seeds of *A. conyzoides* and *B. pilosa* could not germinate in low acidic (pH5) and alkaline condition in (pH9). Similarly, seeds of *C. rotundus* could not germinate in alkaline conditions, pH 8 and 9 (Figure 4 a). The shoot and root length of germinated crop seed of *B. campestris* was found to be significantly high in acidic condition at pH 5 but in *T. aestivum* it was significantly high in alkaline condition of pH8. The shoot and root length of most of the weed seeds (*A. conyzoides*, *C. rotundus* and *G. parviflora*) were found to be significantly high in slightly acidic condition pH 6 except *B. pilosa* where it was significantly high in alkaline condition of pH 8 (Figure 4 b and c).

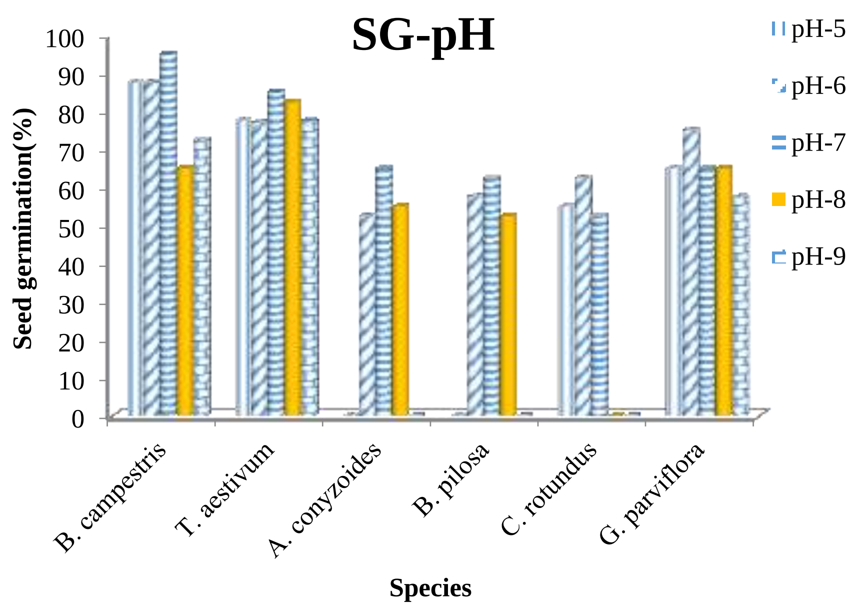

Figure 4a. Seed germination (SG %) of crops (*B. campestris* and *T. aestivum*) and weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different levels of pH (5, 6, 7, 8 and 9).

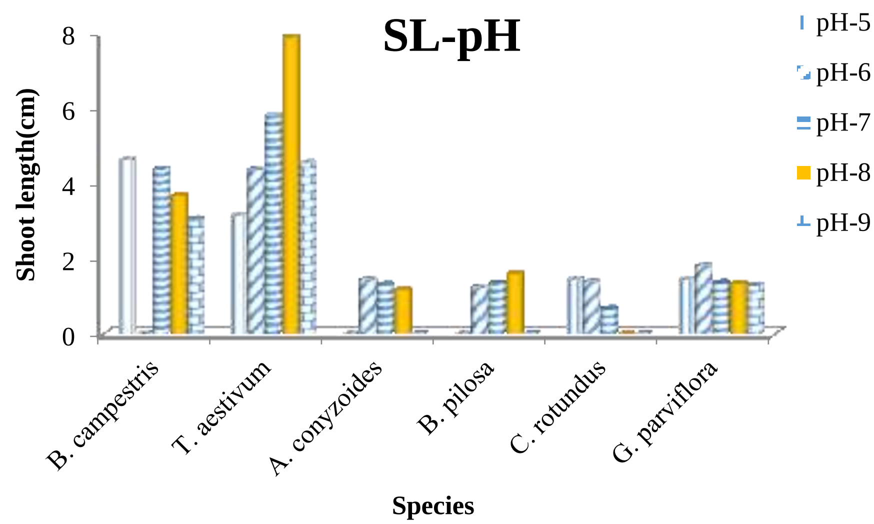

Figure 4b. Shoot length (SL cm) of crops (*B. campestris* and *T. aestivum*) and weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different levels of pH (5, 6, 7, 8 and 9).

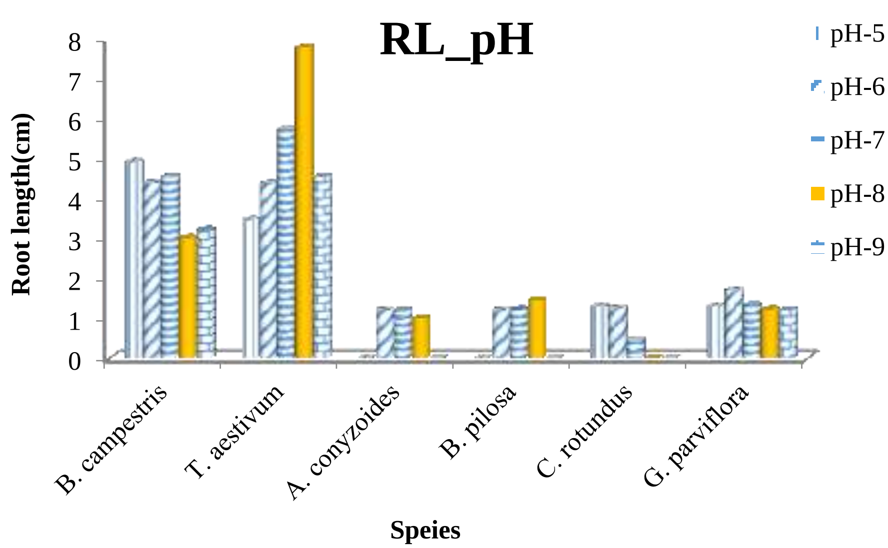

Figure 4c. Root length (RL cm) of crops (*B. campestris* and *T. aestivum*) and weeds (*A. conyzoides*, *B. pilosa*, *C. rotundus* and *G. parviflora*) on different levels of pH (5, 6, 7, 8 and 9).

Both crops and some weeds could germinate from pH 5 to 9, similar results were also reported by Mathews (2012), Hannaway and Larson (2004) that Mustard can adapt in sandy to clay soil and also germinate in the range of pH 4.8 to 8.5. *T. aestivum* have comparatively large seeds with storage of reserve food materials. It appears that both the winter crops have high membrane integrity and could resist high range of pH. Weeds like *A. conyzoides*, *B. pilosa* and *C. rotundus* might have low membrane integrity as a result could not germinate at high pH (McCauley et al. 2017).

The seedling growths (shoot and root length) were approximately same in all seed germination experiments (in moisture, temperature, light and pH) in laboratory conditions might be during their early morphogenesis stages, it strongly depends on the resources stored in the seeds and that these resources determine the magnitude of the response to substrate nutrients. The differences can show when the seed germination experiment will be done in the field because the seed can also take the nutrients from soil in different ratio (Maskova and Hermen, 2018).

Conclusion

Based on the germination, it can be concluded that study of all selected weeds are suppressed with high moisture (i.e., with 15 ml treatment). Seed germination of the entire studied weeds are suppressed in blue light and dark conditions. The high moisture (15ml petridish) showed adverse effects on the seed germination, shoot and root length of *C. rotundus* and *G. parviflora* and also significantly reduced the seed germination of both crops (*B. campestris* and *T. aestivum*) and weed seeds of *A. conyzoides* and *B. pilosa*. Seed germination of both crops and four common weed seeds under different temperatures (5, 10, 15, 20 and 25˚C) showed enhanced seed germination, shoot and root length of both crops at 15 to 20˚C treatments but those of weeds were high at 10 to 15˚C. The percentage of seed germination of both crops *B. campestris* and *T. aestivum* increased significantly in normal and green light. The seed germination, shoot and root length in crop seed of *B. campestris* was found to be significantly high in acidic condition at pH 5 but in *T. aestivum* it was significantly high in alkaline condition of pH8. The shoot and root length of most of the weed seeds (*A. conyzoides*, *C. rotundus* and *G. parviflora*) were found to be significantly high in acidic condition pH 6 except in *B. pilosa* where it was significantly high in alkaline condition of pH 8.

Acknowledgement

The first author is thankful to research grant provided by Professor Emeritus Williams Styan Richards Foundation (PEWSTRIF), Maiduguri, Nigeria for this work. We are also thankful to campus chief and Head of Botany Department, Amrit Campus, Tribhuvan University, Kathmandu, Nepal for providing necessary laboratory facilities and to carry out this research.

Conflicts of Interest

Authors declare no conflict of interest.

References

Assang S, Foster I.A.N, Turner N.C. 2011. The impact of temperature variability on wheat yield. Glob Change Biol. 17: 997-1012.

Auld T.D, Ooi M.K.J. 2009. Heat increases germination of water-permeable seeds of obligate-seeding *Darwinia* species (Myrtaceae). Plant Ecol. 200: 117-127.

Baloch A.H, Rehman U, Ibrahim Z, Buzdar M.A, Saeed A. 2015. The biology of Balochistani weed: *Cyperus rotundus* Linnaeus, A Review. Pure Appl Biol. 4(2): 171-180.

Bartolome A.P, Villaseñor I.M, YanWen C. 2013. Review Article *Bidens pilosa* L. (Asteraceae): Botanical Properties, Traditional Uses, Phytochemistry, and Pharmacology, Hindawi Publishing Corporation Evidence-Based Complementary and Alternative Medicine, Volume 2013, Article ID 340215, p 51.

Batty A.L, Dixon K.W, Brundett M, Sivasithamparam K. 2002. Constraints tosymbiotic germination of terrestrial orchid seed in a mediterranean bushland. New Phytologist. 152(3): 511-520.

Bhattrai T. 2007. Plant physiology First edition, Bhundipuran Prakashan, Kathmanu, Nepal, pp 317.

Cann A.J. 2014. Why small seeds require light to germinate, The influence of light on germination was much stronger in smaller than in larger seeds, Botany One, News and views on plant biology and ecology.

Carpenter W.J, Maekawa S. 1991. Substrate moisture level governs the germination of Verbena seeds, HortScience. 26(12): 1469-1472.

Chatterjee M, Sharma P, Khurana J.P. 2006. Cryptochrome1 from *Brassica nappus is* up regulated by blue light and controls hypocotyl/stem growth and anthocyanin accumulation. Plant Physiol. 141: 61-74.

Cochrane A, Daws M.I, Hay F.R. 2011. Seed-based approach for identifying flora at risk from climate warming, Austral Ecol. 36(8): 923-935.

Coleman M, Kristiansen P, Coleman M, Kristiansen P, Sindel B, Fyfe C. 2018. Nutgrass (*Cyperus rotundus*): Weed management guide for Australian vegetable production. School of Environmental and Rural Science, University of New England, Armidale.

Dangol D.R. 2013. Weeds of Wheat in Nepal :A Literature Review. J Nat Hist Mus .27: 132-178.

Dangol D.R, Chaudhary N.K. 1994. Wheat-Weed Interactions at Rampur, Chitwan,. In: F. P. Neupane (ed.), IAAS Research Reports, pp. 19-37.

Espinosa G, Vas Bravo F.J.R, Martinez-Ramos M. 2003. Survival germinability and Fungal colonization of dimorphic achenes of the annual weed *Galinsoga parviflora* buried in the soil. Weed Res. 43: 269-275.

Feng Y.M, Li D.X, Lin Q.J, Huang H.Y, Li X.S, Liu G. 2002. Invasive Species Campedium, Datasheet, *Ageratum conyzoides* (billy goat weed) Guangxi Southern China. J Agric Sci. 15(1): 54-59.

Fenner M, Thompson K. 2005. The ecology of seeds, Book review for Journal, Annals of Botany 97(1): 260.

Global Invasive Species Database GISD. 2016. Species profile *Ageratum conyzoides*. Available from: http://www.iucngisd.org/gisd/species.php?sc=1493.

Hannaway D.B, Larson C. 2004. Hairy vetch (*Vicia villosa* Roth). Oregon State University. Available:http://forages.oregonstate.edu/php/fact_sheet_print_legume.php? SpecID 41 and use Forage.

Huang Y, Shiang J.C, Wen Y.K. 2012. Floral biology of *Bidens pilosa* var. radiata, an invasive plant in Taiwan. Botanic Stud. 53: 501-507.

Heydecker W, Chetram R.S, Heydecker J.C. 1971. Water relations in beetroot seed germination. II. Effects of the ovary cap and of the endogenous inhibitors. Ann Bot. 35:31-42.

Kaur S, Batish D.R, Kohli R.K, Singh H.P. 2012. CAB International. *Ageratum conyzoides*: An Invasive Alien Plants: An Ecological Appraisal for the Indian Subcontinent.

Kidson R, Westoby M. 2000. Seed Mass and Seedling Dimensions in Relation to Seedling Establishment, Oecologia. 125(1): 11-17.

Kirszenzaft S.L, Felippe G.M. 1978. Effects of photoperiod and growth regulators on flowering of *Bidens pilosa* L., Cienciae cultura. 30: 357-361.

Kolodziejek J, Patykowski J. 2015. Effect of Environmental Factors on Germination and Emergence of Invasive *Rumex confertus* in Central Europe. Sci World J. 170176: 10.

Koutsovoulou K, Dews M.I, Thanos C.A. 2014. Campunulaceae; A family with small seeds that require light for germination. Annals Botany. 113: 135-143.

Kucewich M, Kucewich M, Gojto E. 2014. Influence of achene hetromorphism on life cycle traits on the annual weed (*Galinsoga parviflora* cav.), Flora. 209: 640-654.

Matthews S, Noli E, Demir L, Hosseini K.M, Wagner M.H. 2012. Evaluation of seed quality: from physiology to international standardization. Seed Sci Res. 22: 69-73.

Maskova T, Hermen T. 2018. Root:shoot ratio in developing seedlings: How seedlings change their allocation in response to seed mass and ambient nutrient supply. Ecol Evol. 8(14): 7143-7150.

McCauley A, Clain J, Olson K. 2017. Soil pH and Organic Matter, Nutrient Management, Montana State University,Extension Module No 8. 4449-8.

McErlich A.F, Boydston R.A. 2013. Current State of Weed Management in Organic and Conventional Cropping Systems, Publications from USDA-ARS / UNL Faculty. 1387. http://digitalcommons.unl.edu/usdaarsfacpub/1387.

Milberg P, Andersson L, Thompson K. 2000. Large-seeded species are less dependent on light for germination than small-seeded ones. Seed Sci Res. 10: 99-104.

Monoroe D. 2018. Lab Report- Seed Germination Based on Temperature Factors, https://www.academia.edu/8551066/Seed_germination_based_on_temperature_factors.

Oliviera L.M.Q, Valio I.F.M. 1992, Effects of moisture content on germination of seeds of Hancornia speciosa Gom. (Apocynaceae), JSTOR. Annals Botany. 69: 1-5.

Orphanos P.I, Heydecker W. 1968. On the nature of soaking injury of *Phaseolus vulgaris* seeds. J. Exp. Bot. 19: 770-784.

Patel A, Singh A.K, Singh S.V, Sharma A, Raghuvanshi N, Singh A.K. 2017. Effect of Different Sowing Dates on Growth, Yield and Quality of Various Indian Mustard (*Brassica juncea* L.) Varieties. Int J Curr Microbiol App Sci. 4: 71-77.

Paudel B, Shrestha A, Amgain L.P, Neupane M.P. 2017. Weed Dynamics in Various Cultivars of Rice (*Oryza sativa* L.) under Direct Seeding and Transplanting Conditions in LamjungInt. J. Appl. Sci. Biotechnol. 5(2): 159-167.

Phytochrome. 2013. Light regulates plant growth and development http://www.mobot.org/jwcross/duckweed/phytochrome.htm [accessed 13 March 2019].

Powell A.A. 2010. Morphological and physiological characteristics of seeds and their capacity to germinate and survive, Ann Bot. 105(6): 975-976.

Ranjit J.D, 2002, Response of Wheat Weeds to Straw Mulch in Mid Hills, Proceedings of International Seminar on Mountains- Kathmandu. 6: 372-377.

Ranjit J.D, Robin B, Julie L, Doxhbury J.M. 2009. Impact of Mulching on Wheat Yield and Weed Floras in the Mid Hills of Nepal, Nepal Agric Res.J 9: 21-26.

Ranjit J.D, Bhattarai A.N. 1988. Crop weeds and their control in Nepal. Agricultural Research and Production Project, Winrock International/USAID Project No. 367-0149-3-50002, Kathmandu, Nepal.

Ranjit J.D. 1997. Weeds and weed management in rice-wheat system. In**:** Proceedings of the Rice-Wheat Research end-of-Project Workshop held at Kathmandu, Nepal from 1-3 Oct 1997. 23-30.

Rawal D.S, Kasel S, Keatley M.R, Nitschke C.R. 2015a. Environmental effects on germination phenology of co-occurring eucalypts: implications for regeneration under climate change. Int. J. Biometeorol. 59: 1237- 1252.

Rawal D.S, Kasel S, Keatley M.R, Nitschke C.R. 2015b. Herbarium records identify sensitivity of flowering phenology of eucalypts to climate: Implications for species response to climate change. Austral Ecol. 40(2): 117-125.

Reece J.B, Urry L.A, Cain M.L, Wasserman S.A, Minorsky P.V, Jackson R.B. 2011. Campbell Biology 9th Edition, Pearson Benjamin Cummings, San Francisco.

Sapkota N, Dongol D.R, Bhuju D.R. 2010. Weed species composition and growth in wheat field of mountain ecosystem Khokana, Lalitpur, Nepal. *Botanica Orientalis. J Plant Sci.* 7: 85-91.

Sayed H.M, Mohamed M.H, Farag S.F, Mohamed G.A, Proksch P. 2007. A new steroid glycoside and furochromones from *Cyperus rotundus* L, Nat. Prod. Res. 21: 343-350.

Schonbeck M. 2013. An Ecological Understanding of Weeds, Organic Agriculture, eXtension.

Shah P. 2013. Weeds associated with tillage, mulching and Nitrogen in wheat and their effect on yield a review. Int J Geol Agric Environ. 1: 20.

Shekhawat K, Rathore S.S, Premi O.P, Kandapal B.K, Chauhan J.J. 2012. Advance in Agronomic Management of Indian Mustard (*Brassica junces* L.) Czernj, Cosson: An Overview. Int J Agron. 408284: 14.

Shrestha S, Rawal D.S, Halford J, Adkins S.W. 2017, The effect of water stress and temperature on seed germination of six threatened species of Myrtaceae in Australia. Acad J Sci Res. 5: 745-750.

Singh R.K, Singh R.P, Singh M.K. 2013. Weed management in rapeseed- mustard - a review, Agric Rev. 34: 36-49.

Singh R.B, Paroda R.S. 1994. Sustainability and productivity of rice-wheat system in the Asia Pacific region: research and technology need. In: Sustainability of Rice-Wheat Production System in Asia, pp. 1–35. RAPA Publication, FAO, Bangkok.

Tanveer A, Arshad M.S, Ayub M, Javaid M.M, Yaseen M. 2013. Effect of temperature, light, salinity, drought stress and seeding depth on germination of *Cucumis melo* var. *agrestis*. Pak J Weed Sci Res. 18: 445-459.

Thapa C.B. 2001. Weed Flora of Maize Field in Pokhara, Nepal. Nepal J Sci Technol. 3: 9-14.

Waterhouse D.F. 1993. Prospects for biological control of paddy weeds in south east Asia and some recent success in the biological control of aquatic weed. Camberra Ext. Bul. 366 Australia.

Ward E. 2015. Gardening: The pH of your soil can affect the plant growth and health, Naples daily news, Part of the USA Today Network, Accessed 19 march 2019.

Warwick S.I, Sweet R.D. 1983. The biology of Canadian weeds, 58 *Galinsoga parviflora* and *G. quadriradiata*(=*G. ciliata*). Can. J. Plant Sci. 63: 695-709.

Xu P, Xiang Y, Zhu H, Xu H, Zhang Z, Zhang C, Zhang L, Ma Z. 2009. Wheat Cryptochromes: Subcellular Localization and Involvement in Photomorphogenesis and Osmotic Stress Responses. Plant Physiol. 149: 760-774.

Zhao P, Liu P, Yuan G, Jia J, Li X, Qi D. 2016. New insights on drought stress response by global investigation of gene expression changes in sheepgrass (*Leymus chinensis*). Front. Plant Sci. 7: 954.

Cite this article as: Mallik Baby Babita Das, B.D. Acharya, M. Saquib, M.K. Chettri. 2020. Seed germination and seedling growth of some crops and weed seeds under different environmental conditions. *Journal of Research in Weed Science*, 3(3), 363-381. DOI: 10.26655/JRWEEDSCI.2020.3.8