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Research Article

Effect of Different Temperatures on Germination Parameters of (Coral Trees), *Erythrina Lysistemon* Seeds From Al-Bayda City, Libya

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Abstract—In Libya, there are no papers on the effects of temperature on the germination of imported tree seed. So, this study aimed to determine the optimal temperature for *Erythrina lysistemon* seed germination. Over 10 days, germination tests were performed under five constant temperatures (5, 10, 20, 30 and 40°C), and two alternating temperatures (20-25 °C and 25-30 °C 12 h/ temperature) during the dark period after soaking the scratched seeds in distilled water for 24 hours. Results indicated that different temperatures significantly affected germination at ($p < 0.05$), in the reduction of germination percentage, mean germination time, mean daily germination, radical, plumule and seedling length, seedling vigor index, and fresh seedling weight. The results showed no seed germination occurred under the lowest temperature 5°C, or the highest one 40°C. On the contrary, the germination tests revealed that the optimum temperature was alternating temperature (25-30°C), Followed by constant temperature (30 °C), compared to other temperatures.

Keywords— *Erythrina lysistemon*, Optimum temperature, Germination parameters, Al-Bayda City.

1. Introduction

Coral trees *Erythrina lysistemon* Huch. a multipurpose tree species belonging to the family Fabaceae, distributed predominantly from middle Africa in Tanzania to maximum the African south [1]. The agriculture, industry, and traditional medicine use of *Erythrina* species were reviewed [2,3,4]. *E. lysistemon* contains chemicals such as flavonoids, pterocarpans, and alkaloids [5,6]. *E.lysistemon* is an introduced species cultivated as an ornamental tree, prized for its showy red flowers. Additionally, it serves as a source of shade in hospital gardens and along public thoroughfares in Al-Bayda City, Libya [7]. Due to the multiple uses and ecological services provided by *Erythrina* trees, there is particular interest in their reproduction in propagation and spread in various worldwide [8,9]. Climate change is one of the biggest problems the world is currently experiencing. Such perturbations have the potential to decrease rainfall and increase average annual temperatures [10,11]. All these climatic perturbations contribute to the redistribution and structure of plant communities [12]. As a result, reforestation helps alleviate climate change by reducing atmospheric CO2, and absorbing or reflecting radiation [13]. High-quality tree seeds are the primary means of reproduction for forest restoration and long-term success [14]. However, seed germination primarily depends on optimal temperatures for high germination rates, which vary by species [15]. High temperature inhibits seed germination seedling establishment by ABA and ROS accumulation [16]. Similarly, lower temperatures contribute to seed viability loss by damaging their cytoplasmic membrane and altering energy metabolism [17].

2. Related Work

According to the scientific literature, research on the effects of different temperatures on the *Erythrina* genus seeds is limited. For example, Felix et al. (2020) reported that *Erythrina velutina* seeds reached higher germination percentages when incubated at temperatures of 25 °C [18]. In addition, the highest germination rate (90%) of *Erythrina brucei* seeds was obtained under light at 20°C during the day and 10-12°C at night [19]. In reviewing the literature, we found that no prior study has reported the effect of temperatures on the germination of *Erythrina lysistemon* Huch seeds.

Therefore, the main goal of this research was to determine the optimal temperature germination of *Erythrina lysistemon* Huch seeds.

3. Experimental Method/Procedure/Design

3.1. Study area

The Al-Bayda city is located northeast of Libya, 522.5meters above sea level and it has a total area of 11.429 km2, between

longitudes 32.94 - 31.12 N0 and longitudes 21.25 - 21.93 E0. January is the coldest month of winter, averaging a temperature of 7 ºC, while August is the hottest month of summer, with an average temperature of 23.5 ºC, the highest rainfall is 563 mm yr-1, and most of the precipitation occurs in December, January, and February.

3.2. Seed Material

In Al-Bayda City, *Erythrina lysistemon* seeds were gathered at random from the mature pods of three trees in the park across from the Ministry of Social Affairs' local office for 2024. To evaluate the seeds' viability, they were soaked in distilled water to get rid of any empty seeds, then soaked for five minutes in a 3% sodium hypochlorite solution, and washed three times in distilled water [20].

3.3. Experimental design

The experiment was carried out in the Biology Department laboratory at Omar Al-Mukhtar University's Faculty of Education. Sandpaper was used to mechanically scarify the seeds to prepare them for germination, and they were then immersed in distilled water for a full day [21]. Treatments consisted of five constant temperatures (5, 10, 20, 30, and 40 °C) and two alternating temperatures (20-25 °C and 25-30 °C 12 h period for each temperature). The Germination was carried out in a dark environment in pre-set incubators. 25 seeds/plate was in Petri plates with a diameter of 9cm, containing two Whatman No.1 filter papers. Filter papers were moistened with 10 ml of distilled water plates and incubated at temperatures tested, with three replicates. Germination was calculated by recording the number of germinated seeds in all treatments starting on the second day of observation when germination first occurred. The seeds were considered germinated at the exit of the radicle outside the seed cover, and germination was counted daily for ten days [22].

3.4. Germination parameters

The evaluated variables were: germination percentage, mean germination time, mean daily germination, seedling vigor index, radical, plumule, and seedling lengths and fresh seedling weight. for each variables formula and the source are given in Table (1).

Table.1. Description of germination parameters used in the study.

Variables	Formula	Ref.
Germination Percentage (PG%)	number of germinated seeds / total number of seeds cultured × 100	[22]
Mean germination time (MGT) (day)	The total number of germinated seeds per day / total number of germinated seeds at end of the experiment	[22]
Mean daily germination MDG	MDG = FG/ MGT)	[23]
Seedling vigor index (SVI)	germination percentage x seedling length (cm)	[24]
Radical, plumule, and seedling lengths (cm)	the lengths were taken using a graduated ruler, and the averages were calculated	-
Fresh seedling weight (g)	weight of Each seedlings from each plate	-

3.5. Statistical Analysis

The experiment was carried out in a completely randomized design (CRD). The analysis of variance (ANOVA) and the comparisons of means by Tukey's test at $p<0.05$, were performed using Minitab 17.

4. Results and Discussion

Current work shows in Figures (1-8) an effect of Temperature levels under dark conditions of five constant temperatures (5, 10, 20, 30, and 40°C) as well as two alternating temperatures (20-25 °C and 25-30 °C 12 h/ temperature) on germination parameters of *Erythrina lysistemon*, after 10 days from the start of the experiment. The high and low temperatures significantly affected germination at ($p <0.05$), where the results of our study showed no seed germination occurred under the lowest temperature 5°C, or the highest one 40°C. These results corroborate [25] reported with the germination of four seed Caatinga tree species, at 5°C. In addition to these authors [26] noted that no seed germination occurred under the highest one 40°C *Moringa* seed. The high temperatures (40°C) negatively impact the metabolic processes of seeds, leading to dysfunctional mitochondria and decreased respiration rates, ultimately hindering germination and seedling establishment [27]. Further, it is outlined that high temperatures may increase the levels of reactive oxygen species, malonaldehyde, and carbonylated proteins while simultaneously decreasing the activities of ascorbate peroxidase, catalase, peroxidase, and α-amylase [28]. In a recent study [29] reported that reactive oxygen species (ROS) play a vital role in regulating ethylene, abscisic acid, and gibberellic acid, as well as in Ca2+ signaling, NO signaling, MAPK cascade, and nuclear genome remodeling during seed germination. The findings tests revealed that seeds grown at alternating temperatures (25-30 °C), were found significantly superior in achieving the best maximum values of various germination parameters of germination percentage (89.33%), mean germination time (3.20 days), mean daily germination (27.91), radical length (4.4cm), plumule length (4.9cm), seedling length (9.3cm), seedling vigor index (830.7), and fresh seedling weight (0.232g). Similar results confirmed that temperature alternation (25-30 °C) positively affects the seed germination of *Albizia niopoides* [30], and *Parkia nitida* [31]. Followed by constant temperature (30 °C), which achieved good results compared to other temperatures on *E.lysistemon* germination parameters, where recorded germination percentage (84.00%), mean germination time (3.41days), mean daily

germination (24.63), radical length (4.2cm), plumule length (4.5cm), seedling length (8.7cm), seedling vigor index (730.8) and fresh seedling weight (0.200g). On the other hand, the statistical analysis indicated in (Fig 2) shows no significant difference in the mean germination time between seeds cultured at 25-30 °C, and 30 °C, which is similar to the results shown by [32] in *Crescentia alata*, and by [33] in *Dracaena cinnabari*. Optimum temperatures achieve the highest germination rates by regulating (ABA and GA) levels and reactivating metabolic activities to mobilize nutrients stored and accelerating hydrolysis through the activity of catalytic enzymes amylases, lipases, and proteases [34] in addition to scavenging reactive oxygen species through different antioxidant mechanisms [35]. In contrast, the statistical analysis indicated that *E.lysistemon* germination parameters tend to slightly decrease with low alternating temperature to 20−25 °C, where recorded germination percentage (62.66%), mean germination time (4.44 days), mean daily germination (14.11), radical length (3.7cm), plumule length (3.5cm), seedling length (7.2cm), seedling vigor index (451) and fresh seedling weight (0.184g). Seeds cultured at 20°C showed a low germination percentage (36.00%), causing a delay in the mean germination time and mean daily germination decreased to (4.85 days, 7.42), respectively. The lengths of radical, plumule, and seedlings were (2.9, 3.2 and 6.1cm) respectively, while the seedling vigor index was (219.6) and fresh seedling weight (0.156g). No statistically significant difference in the mean daily germination was observed between 20 °C and 20−25 °C. Specifically, germination performance negatively interacted with both germination low temperatures and germination parameters, the lowest decline in various germination parameters of *E.lysistemon* at 10 °C, with germination percentage (5.33%), mean germination time (4.50 days), mean daily germination (1.18), radical length (1.2cm), plumule length (2.8cm), seedling length (4.0cm), seedling vigor index (21.3) and fresh seedling weight (0.140g). Moreover, no statistically significant difference in the mean daily germination was observed among the 10 °C, and two temperatures (5 °C and 40 °C.). The inhibitory effects of low temperatures on germination parameters were reported in studies on the germination of *Horsfieldia hainanensis* and *Pinus patula* seed [36,37].

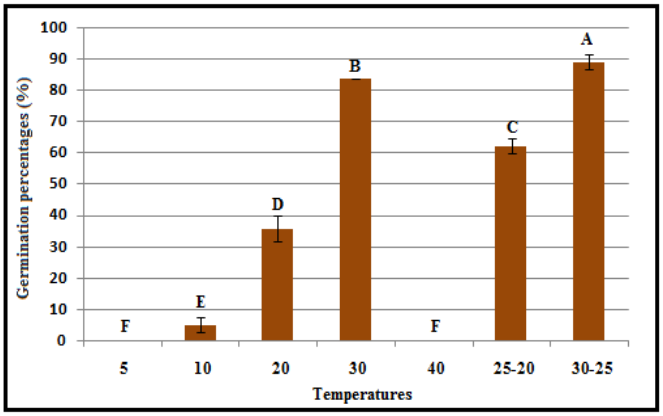

Figure 1. The effects of different temperatures on the germination percentage of *Erythrina lysistemon* seeds. (Mean ± Standard Deviation). Columns with the same letter values do not differ from each other by the Tukey test (5%).

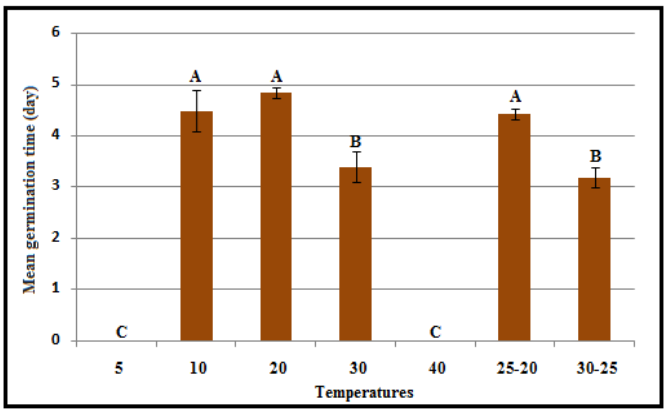

Figure 2. The effects of different temperatures on the mean germination time of *Erythrina lysistemon* seeds.

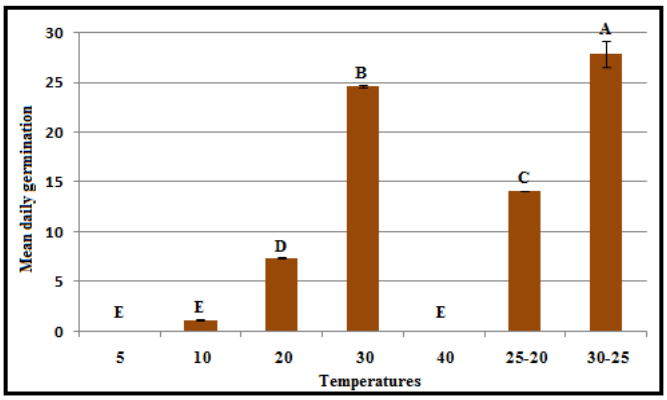

Figure 3. The effects of different temperatures on the mean daily germination of *Erythrina lysistemon* seeds.

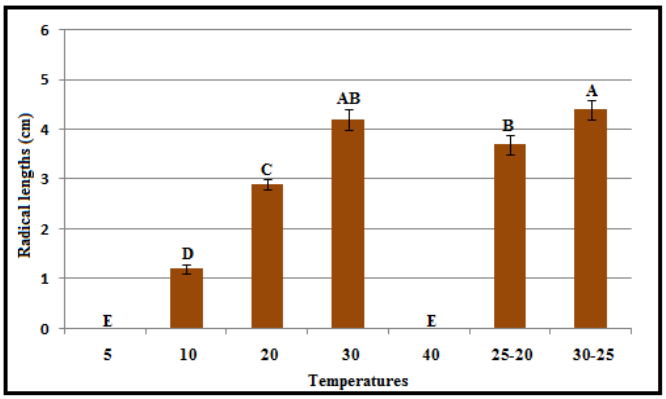

Figure 4. The effects of different temperatures on the radical lengths of *Erythrina lysistemon* seeds.

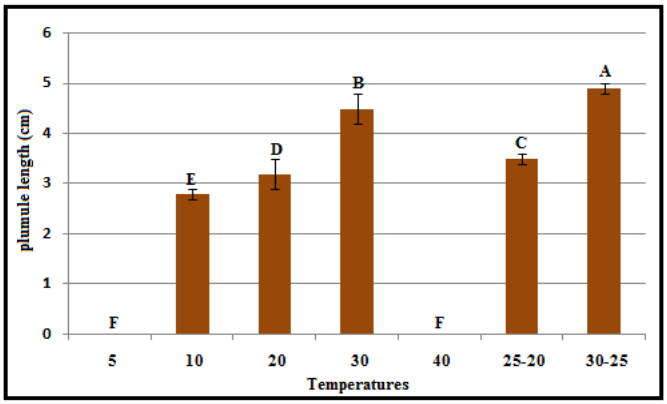

Figure 5. The effects of different temperatures on the plumule lengths of *Erythrina lysistemon* seeds.

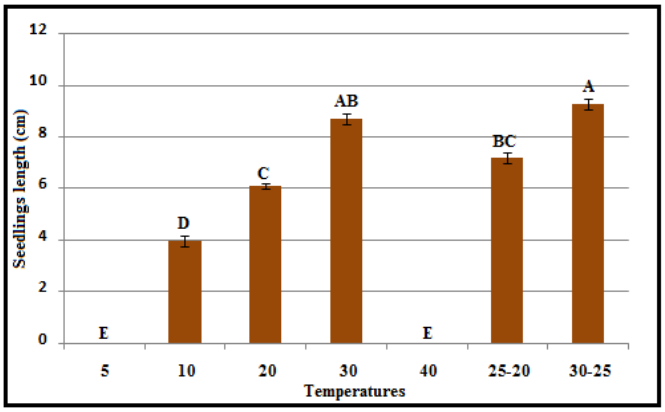

Figure 6. The effects of different temperatures on the seedling lengths of *Erythrina lysistemon* seeds.

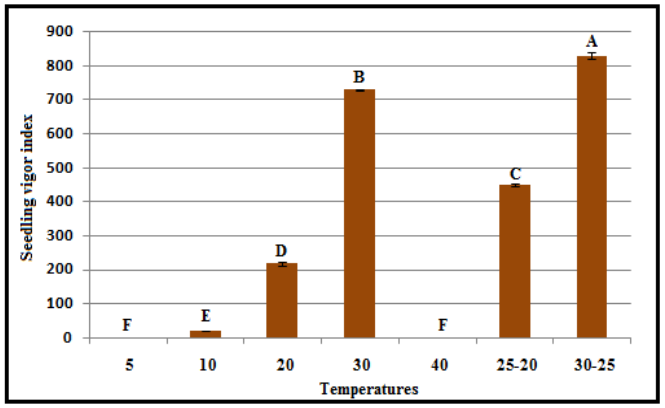

Figure 7. The effects of different temperatures on the seedling vigor index of *Erythrina lysistemon* seeds.

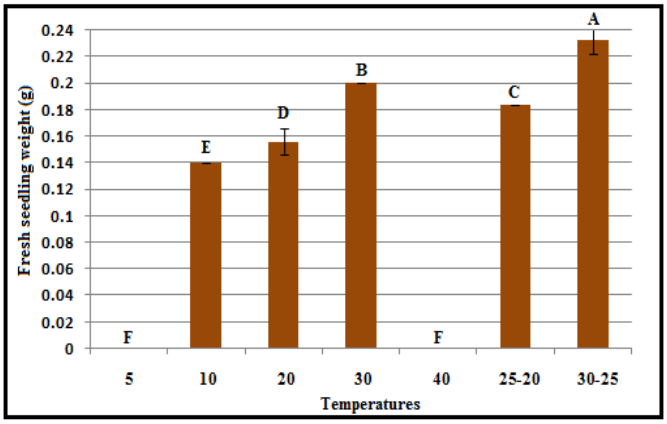

Figure 8. The effects of different temperatures on the fresh seedling weight of *Erythrina lysistemon* seeds.

5. Conclusion and Future Scope

Using introduced species from *Erythrina lysistemon* for ornamental purposes can contribute to reforestation and help alleviate climate change by reducing atmospheric CO2. In this study, germination tests revealed that the optimum temperature was alternating temperature (25-30°C) with germination percentage (89.33%), Followed by constant (30°C) with germination percentage (84.00%). Temperatures of 5°C and 40°C did not show any seed germination. Additionally, the study found that Erythrina trees are suited to the climate of Al Bayda, Libya. The study suggests carrying out more research on recently introduced species in the future to ascertain how well they have adapted to the local climate.

Data Availability

Data are available upon request from the corresponding author.

Conflict of Interest

The authors declare that there is no conflict of interest.

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Authors' Contributions

The idea for the article was suggested by Mr. Sami M. Salih.
The literature search was performed by Mr. Sami M. Salih & Ahmed A. Abdulrraziq.
The practical experiment was conducted by Mr. Sami M. Salih.
Data analysis was performed by Mr. Ahmed A. Abdulrraziq.
Revising the work was performed by Mr. Sami M. Salih.
Both authors read and approved the final manuscript.

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