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VARIABILITY OF DORMANCY BREAKING TREATMENTS IN SOME DESERT PLANT SPECIES.

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Abstract *:* Dormancy is a critical stage in the life cycle of many plant species, during which seeds or buds enter a state of suspended growth or development. Dormancy enables plants to survive unfavourable conditions and ensures the synchronisation of germination or bud break with suitable environmental cues. However, breaking dormancy can be challenging for researchers and horticulturists aiming to propagate or cultivate plants. Seeds of nine desert species were sown in Petri dishes and subjected to Various dormancy-breaking treatments, focusing on sulfuric acid treatment, gibberellic acid (GA) treatment, high-temperature treatment, low-temperature treatment, soaking treatment, citric acid treatment, and hydrogen peroxide (H2O2) treatment. The seeds germinated well at day/night temperatures of 25/20 °C. Seeds germinated best in the dark, and the germination was recorded at three germination times (day 3, day 6 and day 27 of sewing). The vitality was measured at day 27. Scanning electron microscope (SEM) was used to determine the morphological variation of plants seeds under study. The research aimed to investigate the relationship between seed cover or testa structure and pretreatment germination methods in various desert plant species. The results showed that H2SO4 treatment significantly increased the germination of Acacia tortilis seeds, while Gibberellic Acid (GA) treatment promoted the germination rates of Acacia gerrardii seeds. Soaking treatment enhanced seed vitality in Acacia gerrardii and Horwoodia dicksoniae. Low-temperature treatment had positive effects on Acacia seyal and Calligonum comosum. Panicum turgidum exhibited increased germination under low temperature, soaking, GA, and high-temperature treatments. Citric acid and H2O2 inhibited germination in some species. Scanning electron microscopy revealed distinct seed coat patterns among the different plant species. Overall, the study highlighted the effectiveness of specific treatments in breaking seed dormancy and promoting germination and vitality in various plant species, and suggest that testa structure and seed vitality should be considered when assessing germination in desert species. Further research is needed to understand dormancy treatment variability's underlying mechanisms and genetic factors.
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***Index Terms*: desert plant, Seed dormancy, treatment, Seeds germination, vitality, testa structure, seed coat**.

I. INTRODUCTION

Native plants are essential for restoring habitats because they are well adapted to local settings, frequently demand fewer resources, require less upkeep, and promote biodiversity and ecosystem stability. Additionally, these plants aid in soil stabilization, erosion prevention, and lowering chemical discharge into rivers. Plants' production can be decreased for many reasons such as environmental stress and seed dormancy.

Seed dormancy (SD) in arid plants is a survival mechanism that allows the seeds to remain viable until the conditions are suitable for germination. Arid plants have adapted to survive in dry and harsh environments, and their seeds have evolved to remain dormant until enough moisture is available to support germination. This survival can be related to seed mass, shape and coat thickness (Traveset et al., 2007). The inability of a viable seed to germinate under environmental conditions is known as seed dormancy (SD). It has an advantage and disadvantages in terms of plant production. SD has several positive impacts as it plays an important role in physiological and ecological adaptation, such as helping terrestrial plants survive in harsh environments and maintain their vitality, which ultimately leads to evolution, survival, and continuation of the species (KE and Boboye, 2022).

Dormancy can be considered an issue in the case of producing a large number of seedlings and for the restoration of endangered species, which sometimes takes a couple of seasons to become nondormant and finally reduce the germination percentages. Dormant seeds could be lost through microbial attack or animal foraging soil erosion, obstructing plant recovery (Chen et al., 2022). An in-depth understanding of seed viability, storage, sowing time, germination parameters, and seedling care is crucial when growing plants from seeds. (Taylor, 2020) (Kameswara Rao et al., 2017).

There are different types of seed dormancy in arid plants, including physical dormancy, chemical dormancy, and physiological dormancy. Physical dormancy refers to the hard seed coat that prevents water from entering. Seeds may exhibit structural adaptations to regulate or facilitate imbibition or germination (Boesewinkel and Bouman, 2017).

Several mechanisms, such as abrasion, which can occur naturally through microbial activity, passage through an animal's digestive system, freezing and thawing cycles, or mechanical forces. In horticulture and agriculture, humans intentionally induce damage or weakening to the outer coverings of seeds through a process known as scarification. Chemical scarification involves subjecting seeds to various treatments, including immersion in potent sulfuric acid, using organic solvents like acetone or alcohol, or exposure to elevated temperatures like boiling water. Mechanical scarification involves subjecting the material to agitation using an abrasive substance like sand or by creating scratches with a knife.

It has been shown that the physical dormancy of seeds can be broken after treating them with one of the pre-treatment methods, such as chemical scarification or incubating for a period at low temperature. Pre-treatment methods can alter the seed coat and promote vitality, increasing germination probability when physical dormancy is broken (Peco et al., 2006), or seed death when the embryo is damaged (Campos et al., 2008).

In many desert plant seeds, dormancy is due to the impermeability of the seed coat to water (Drumond and Ribaski, 2010). In order to increase the impermeability of the seed coat and enhance water observation, germination pre-treating seeds is crucial. Breaking seed dormancy can be done physically by scarifying the seeds or chemically by soaking them in KNO_3, hot water treatment, cold water treatment, thiourea, cow urine, Sulphuric acid, Hydrogen peroxide, NaOH, or GA_3 (Mohan and Udayan, 2014) .The seed treatment increases embryo growth potential, shortens germination time, weakens seed coat, and encourages the highest possible germination rate (Jawhari et al., 2023). For example, the custard apple seed (*Annona squamosa* L.), which have been used as folk medicines worldwide (Chen et al., 2011), treatment seeds of this species with GA_3 for 48 hours maximum germination percentage of seedling height (Gharge et al., 2011), (Jadhav et al., 2015), (Patel et al., 2016).The pre-sewing treatment with acid is another example of a chemical used in release dormancy research. (KE and Boboye) was recommends that *Plukenetia conophora* seeds be soaked in concentrated sulphuric acid for 20 minutes to produce the highest mean germination value.

Moreover, sulfuric acid was used to improve seed germination of Sabina vulgaris Ant for Optimal germination conditions (Tanaka-Oda et al., 2009). The success of breaking seed dormancy is not the only obstacle in increasing growth at target plants; seed vitality plays an important role in a plant's growth journey and should be considered in pre-treatment methods for plants under study. Therefore, seed pre-treatments are successful if they increase seed germination rates and improve seedling growth (seed vitality).

The outer covering of the seed is known as a seed coat. It protects the embryo from drying out and from any injuries. Seed coats can be thin and soft as well as hard as in coconut shell. Also, the testa texture is one if seed features which is refers to the appearance of the seed coat. The Testa texture plays a vital role in the germination process and in seed dormancy. The diversity of teata surface structures and curvatures might contribute to the seeds' hardness and ability to absorb water (Kiel and McDade, 2014) (Debeaujon et al., 2000).

A minimum of three mechanisms via which a rigid testa might contribute to the induction of seed dormancy. Firstly, it can mechanically limit the expansion of the embryo. Secondly, it can obstruct the entrance of water. Lastly, it may restrict gas exchange, depriving the embryos of oxygen (Smýkal et al., 2014). The resistance of the testa to water absorption is a common characteristic observed in the legume family. The seed coats of legumes typically exhibit hardness, smoothness, and sometimes even a glass-like appearance (Rodrigues-Junior et al., 2020).

Furthermore, low seed germination in arid and semi-arid regions is brought on by the water-impermeable seed coat, or embryo-imposed, or a combination of the two (Kelly et al., 1992). which induces physical dormancy. Under ideal circumstances, seed dormancy prevents an undamaged, viable seed from fully germinating. For instance, most Acacia seeds do not germinate when exposed to conditions typically favorable for germination because of their water-impermeable seed coat. Because of this, it is impossible to achieve consistent germination in the nursery, and Acacia seeds can take up to 6 months to germinate. Suppose the species of Acacia is to be successfully incorporated into various planting programs. In that case, the seeds of the Acacia species must be exposed to some physical or chemical treatment to break dormancy and obtain quick germination (El-Azazi et al., 2013). Pre-sowing treatments for seeds cause the impenetrable seed coat to crack, allowing the embryo to imbibe the water.

For this investigation, the effect of various pre-sowing treatments on seed germination and vitality was evaluated for some desert plants. The results of this study highlight the importance of identifying the most effective dormancy-breaking treatments for specific plant species, as this knowledge can inform conservation and afforestation programs in the desert ecosystem.

II. RESEARCH METHODOLOGY

2.1 Seed collection

Seeds of nine desert plant species were collected on March- May of 2022 (two weeks from starting the experiment) from different places in central reign of Saudi Arabia. The seeds that were investigated in this study as following: three species of trees:

Acacia tortilis, *Acacia gerrardii*, *Acacia ehrenbergiana*, *Acacia seyal*. Two shurbs: *Calligonum comosum* and *Rhanterium epapposum*. Three herbs *Panicum turgidum*, *Horwoodia dicksoniae* and *Cenchrus ciliaris.* Damaged and empty seeds were excluded via hand and floating test respectively before the beginning of germination experiment.

2.2 Seed Pre-treatments

In this experiment seven different treatment were used as the flowing. All treatments included three replicates, And incubate at at 22°C in a dark growth chamber then transfer to growth chamber room with 14h light/10h dark with 50% humidity.

2.2.1 Sulfuric acid treatment

Seed were soaked in 98% sulfuric acid for 30 minutes. Also the seed were soaked in 50% sulfuric acid for 10 minutes .The seeds were removed from the acid and thoroughly washed several times with distilled water to eject the acid **.**

2.2.2 Gibberellic acid (GA) treatment

Seeds were soaked for 24 hours in GA3 aqueous solutions at 100 mg L concentrations. The seeds were then sterilized with a 1% NaClO solution at room temperature, followed by a sterile distilled water wash.

2.2.3 High temperature treatment

The seeds were soaked with boiled water (100 C) and lifted to cool gradually for 24 hours.

2.2.4 Low temperature treatment

Seed were placed in cold environment 4-5 degree for 15 days then transferred the seeds to the growth chamber at 22°C.

2.2.5 Soaking treatment

Seed were soaked in distilled water for 24 hours then placed in growth chamber at 22°C

2.2.6 Citric Acid treatment

Seed were soaked in citric acid 99% for 24 hours then placed in growth chamber at 22°C.

2.2.7 Hydrogen peroxide (H_2O_2) treatment

Seed were soaked in H_2O_2 (20 %) for 10 minutes then placed in growth chamber at 22°C.

2.3 Seed Germination

Germination rate and vitality were measured for all treatments to identify the effect of different seed pre-treatments on the germination and vitality of the seeds under study. Ten seeds of each pre-treatment were put in a petri dish, which contains a wet filter paper. The petri dishes were kept under l growth chamber condition, distilled water was added as needed to keep the filter papers moist. Then, germination percentage and vitality of germination were measured during three growth times (day 3, day 9 and day 27 from first day left in growth chamber) by the following equations:

$$Germenation\,\%\,(GI) = \frac{Number\ of\ germinated\ seed}{Total\ number\ of\ seeds\ sown} \times 100$$

Ten seedlings per dish were randomly selected after 27 days of germination, and the height of the seedlings (S) was measured with a standard ruler (cm). The seed vitality index (VI) was then calculated as follows:

$$\mathrm{VI} = \mathrm{GI} * \mathrm{S}$$

where GI is the germination index and S is the average height of the seedlings. (Yang et al., 2019).

2.4 Seed Coat Structure

The subtle morphology of the outer surfaces of the seed coat was measured under a scanning electron microscope (SEM) (JSM-6380 LA). The SEM experiment covered the control seeds that received no treatment. Plants species under study was set with three replicates of 100 seeds each. The seeds were gold-coated with a gold sputter coat instrument (HITACHI E-1010) and viewed under the SEM in high vacuum mode. Images were captured under a scanning microscope at 10KV (X10000). SEM image analysis and processing were conducted using the public domain Java-based.

2.5 Statistical Analyses

Statistical analysis was performed using SPSS 2. The data represent means calculated from four replicates for the measured parameters and Physiological parameters. The analysis of variance was done using ANOVA followed by F-test analysis. The values are means ±SD and statistical signific significance was set up to $p < 0.05$.

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III. RESULTS

3.1 Germination and vitality index under seed pretreatment

The results revealed that the H_2SO_4 treatment significantly increased the germination of *Acacia tortilis* seeds compared to the other dormancy-breaking treatments. The seeds treated with H2SO4 exhibited faster germination and higher overall germination rates. The other treatments showed varying degrees of effectiveness in breaking seed dormancy, with some treatments exhibiting limited impact on germination (Figure 1.A),(Figure 1.A).

Also, its indicated that Gibberellic Acid (GA) treatment significantly increased the germination rates of *Acacia gerrardii* seeds compared to other treatments at the full germination time. However, the soaking treatment exhibited higher seed vitality compared to the control group, indicating a potential enhancement of seed vigor and viability. Statistical analysis confirmed the significant effects of the treatments on seed germination and vitality, highlighting the efficacy of GA and soaking in breaking dormancy and promoting seedling establishment. (Figure 2.A) (Figure 2.B).

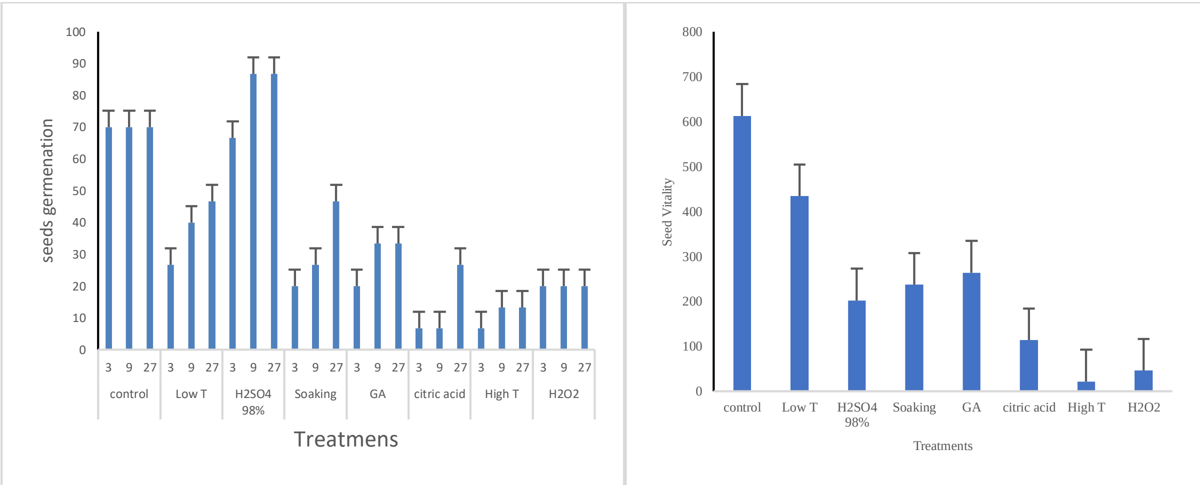

Figure 1 *Acacia tortilis under different treatments. A. Seed germination percentage. B. Seed Vitality index.*

Acacia ehrenbergiana had an increased at high temperature treatment in the seed germination more than other treatments at full germination time (day 27) (Figure 3.A). However, the seed vitality was decreased under all treatments compared to control (Figure 3.B). The results showed similarity increase of the seed germination (Figure 4.A) and Vitality index (Figure 4.B) under low-temperature treatment on ***Acacia seyal***.

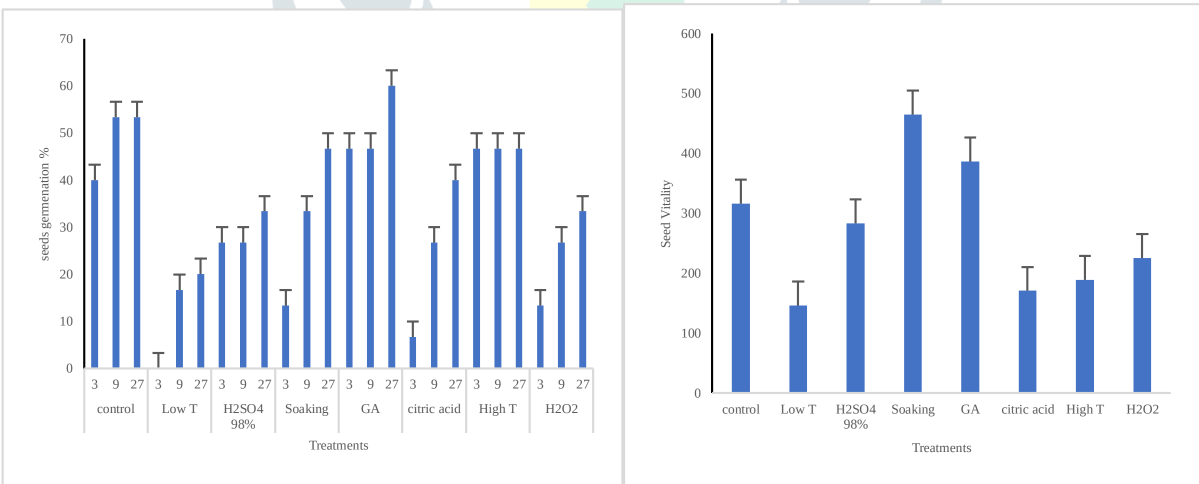

Figure 2 *Acacia gerrardii under different treatments. A. Seed germination percentage. B. Seed Vitality index.*

Moreover, the results showed that some species had increased the seeds germination and vitality index under several treatments such as ***Panicum turgidum,*** which had seed germination increased under low temperature, soaking, GA and High temperature treatment. Although, H_2So_4 and Citric acid inhibition seeds germination at all germination times (Figure 5.A). On the other hand, the high temperature, low temperature treatment had a high seed vitality index compared with the control (Figure 5.B).

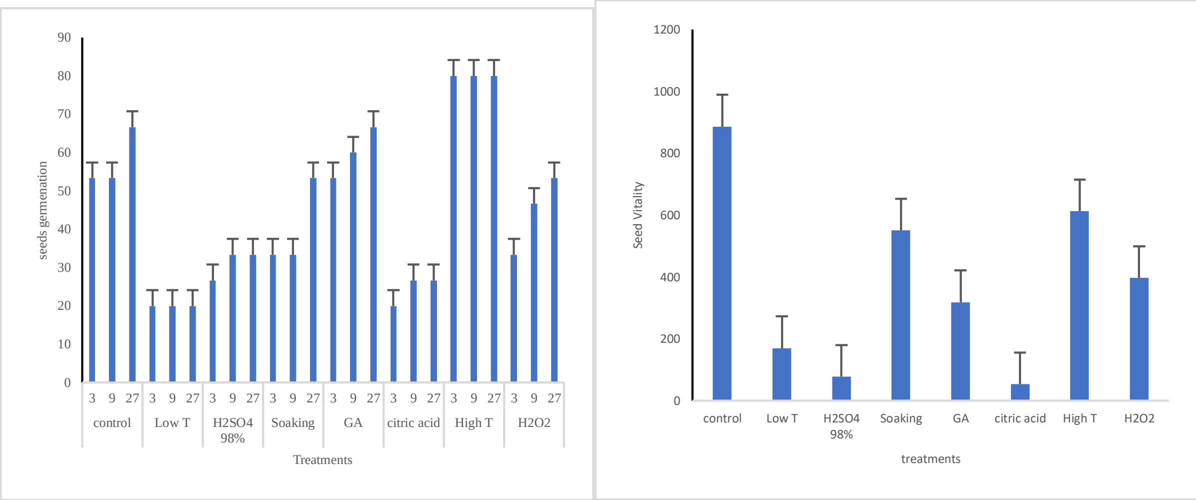

Figure 3 *Acacia ehrenbergiana under different treatments. A. Seed germination percentage. B. Seed Vitality index.*

In contrast, the high-temperature treatment showed a response similar to the control group, with no significant difference in seed germination and vitality. However, the soaking treatment demonstrated a significant increase in seed vitality compared to all other treatments, including the control group. This suggests that soaking treatment effectively broke the dormancy of ***Horwoodia dicksoniae*** seeds and promoted germination (Figure 6.A) (Figure 6.B).

The results of the experiment demonstrated distinct impacts of the various treatments on dormancy breakage and germination of ***Calligonum comosum*** seeds. The germination percentage was highest in the gibberellic acid treatment group, indicating the potential of gibberellic acid in promoting germination in these seeds. However, the low-temperature treatment resulted in the highest seed vitality, as evidenced by robust seedling vigor and overall health of the germinated seedlings. High-temperature treatment and hydrogen peroxide showed moderate effects on dormancy breakage and germination, while the control group exhibited the lowest germination percentage and seed vitality. (Figure 7.A) (Figure 7.B).

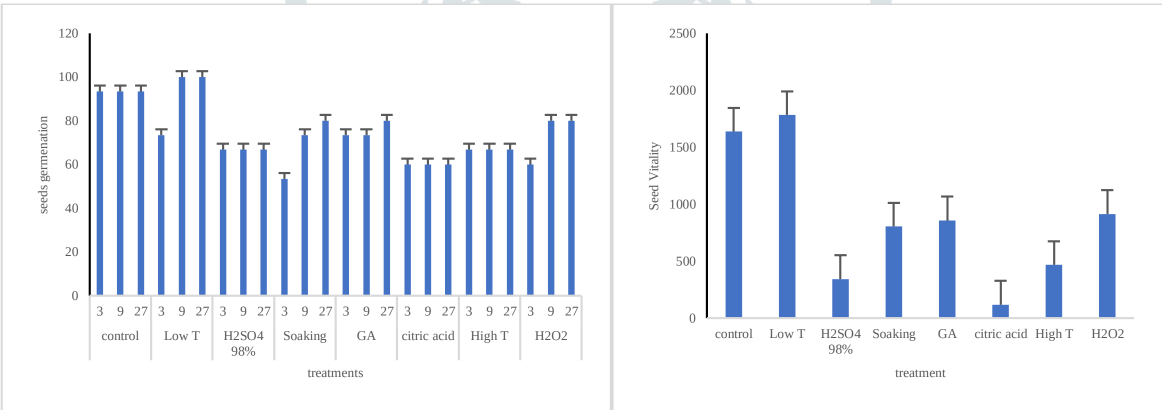

Figure 4 *Acacia seyal* under different treatment. A. Seed germination Percentage. B. Seed Viability index

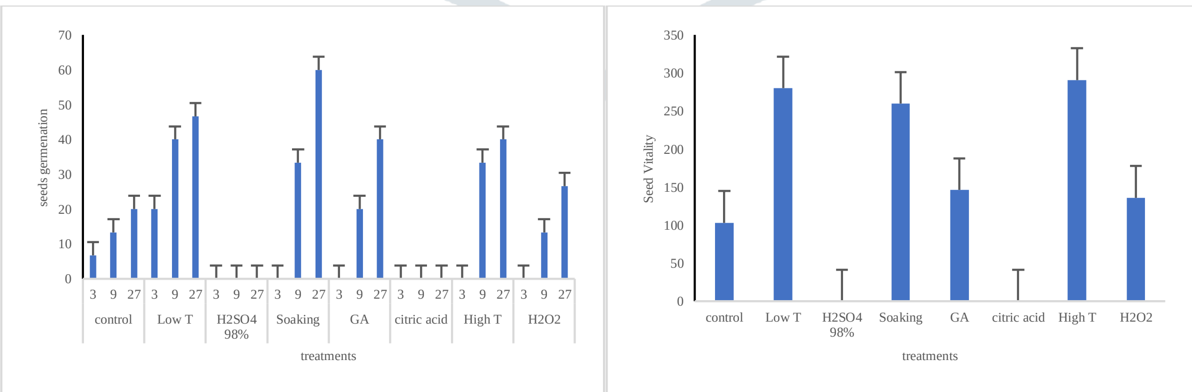

Figure 4 *Panicum turgidum* under different treatments. A. Seed germination percentage. B. Seed Vitality index.

Furthermore, the germination experiments and seed vitality assessments revealed the impact of gibberellic acid (GA3) on the seed dormancy and germination of ***Rhanterium epapposum***. The germination percentage of seeds treated with GA3 was significantly higher compared to untreated seeds and those subjected to other dormancy treatments. Additionally, the time to germination was notably reduced in GA3-treated seeds, indicating the effectiveness of GA3 in breaking seed dormancy. Statistical analysis confirmed the significant influence of GA3 on seed germination parameters, highlighting its role in overcoming seed dormancy and promoting the successful germination of *Rhanterium epapposum* seeds. (Figure 8.A) (Figure 8.B).

The flowing treatments had increased the germination of ***Cenchrus ciliaris*** compared to control, low temperatures, soaking and H_2O_2 treatments (Figure 9.A). The H2O2 treatments had the highest germination percentage and low temperature treatment had the highest seed vitality index (Figure 9.B).

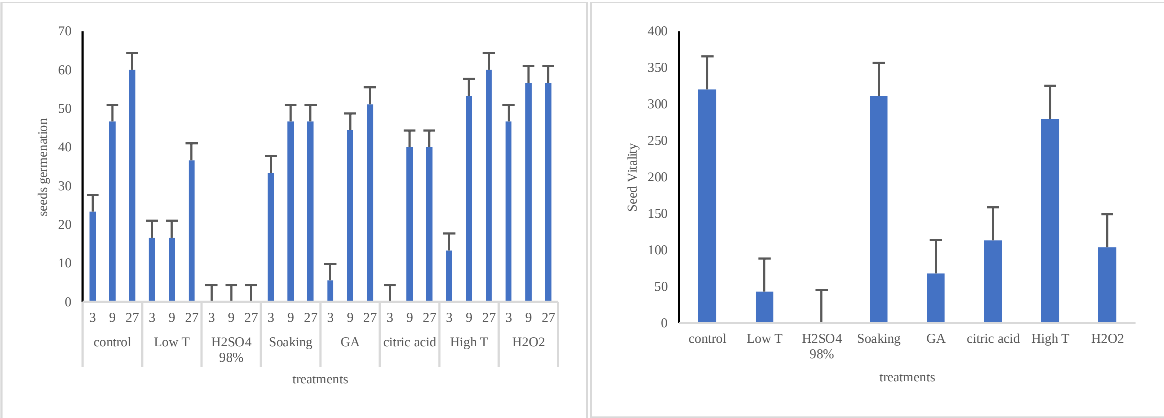

Figure 5 *Horwoodia dicksoniae* under different treatments. A. Seed germination percentage. B**.** Seed Vitality index.

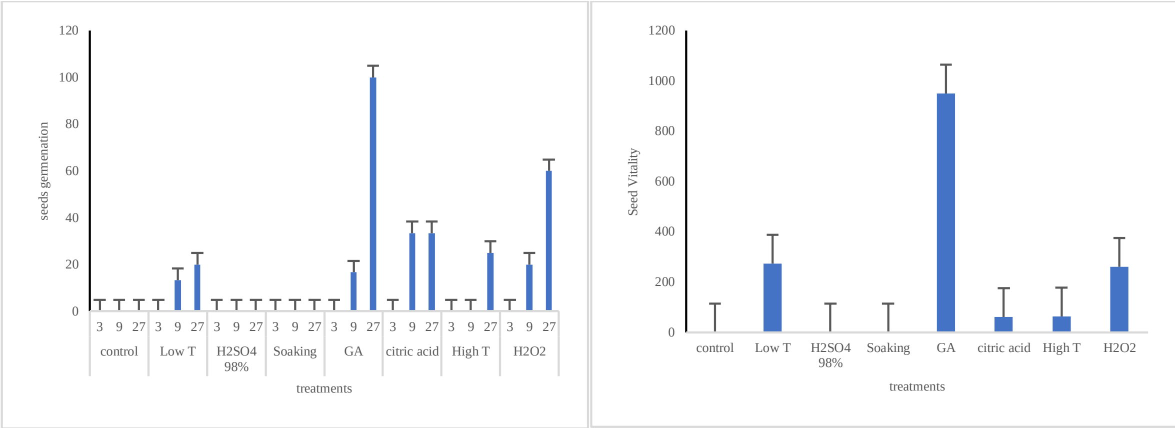

Figure 6 *Calligonum comosum* under different treatments. A. Seed germination percentage. B. Seed Vitality

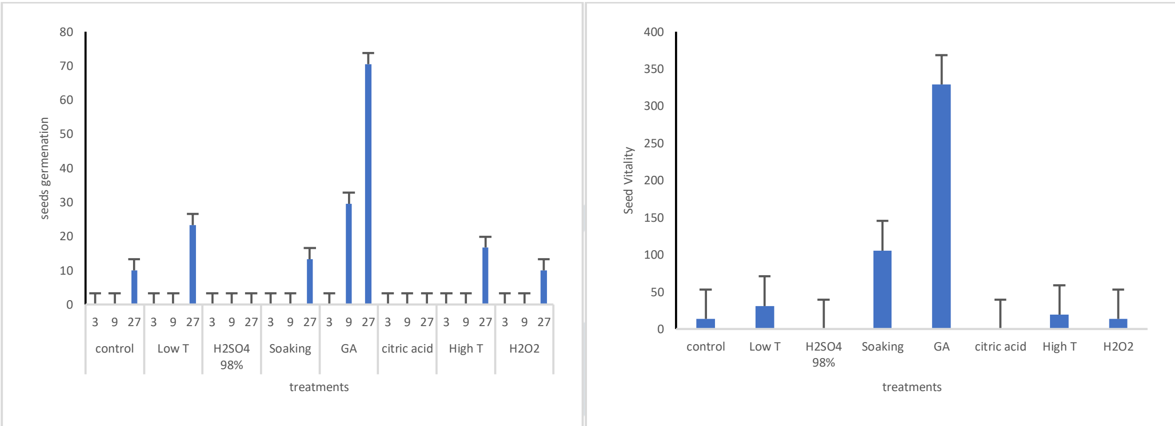

Figure 7 *Rhanterium epapposum* under different treatments. A. Seed germination percentage. B. Seed Vitality index.

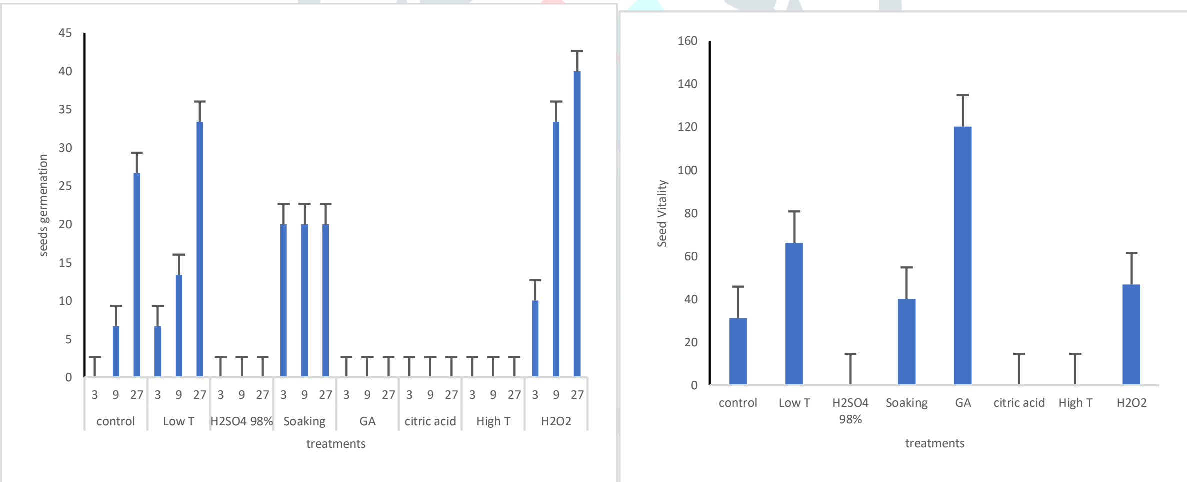

Figure 8 *Cenchrus ciliaris* under different treatments. A. Seed germination percentage. B. Seed Vitality index.

3.2 Scanning electron microscopy micrographs images of Seed coat surface

Scanning electron microscopy micrographs images of the nine deserts plant seeds in control treatment showed that *Acacia tortilis*, , *Acacia ehrenbergiana*, *Acacia seyal* and *Horwoodia dicksoniae* had outer periclinal cell wall with visible shallow depressions and finely striated surface. Yet, *Acacia gerrardii* had Reticulate-foveolate seed coat pattern showing hexagonal cells with concave outer periclinal walls and distinctly raised anticlinal boundaries. the remain plant species under study (*Panicum turgidum*.,*Calligonum comosum*., *Rhanterium epapposum*., and *Cenchrus ciliaris*) the testa is covered with hairlike, Pointed to sharp appendages with a different length and thickens. (Figure 10).

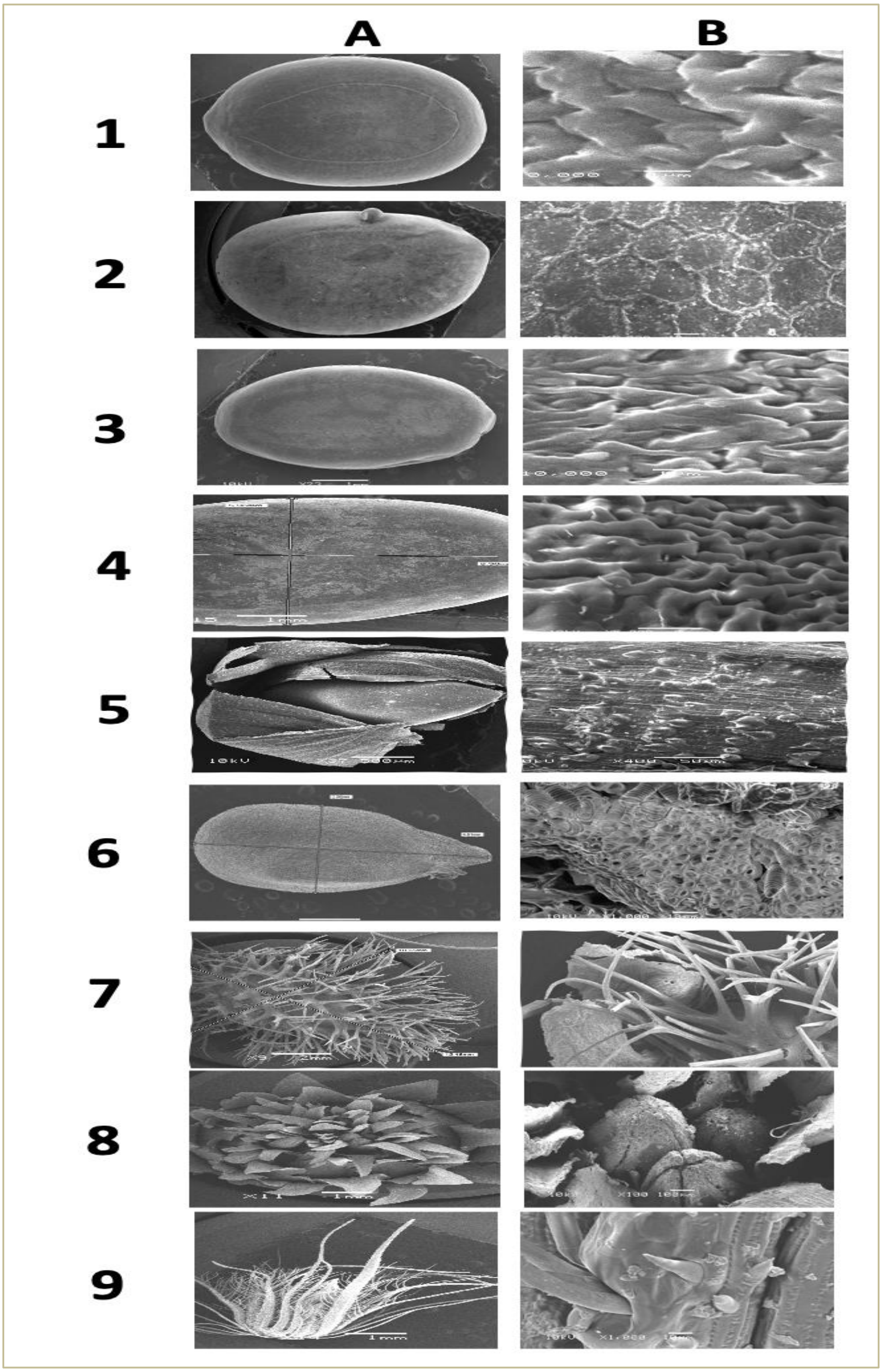

Figure 9 Scanning electron microscopy micrographs of the nine deserts plant seeds under study and a detail of their surface. A. Whole seed B. The surface. 1. *Acacia tortilis.* 2. *Acacia gerrardii.* 3.*Acacia ehrenbergiana.* 4.*Acacia seyal*. 5. *Panicum turgidum. 6. Horwoodia dicksoniae. 7. Calligonum comosum. 8. Rhanterium epapposum. 9. cenchrus ciliaris.* Scale bars for 10 KV (X10000).

1V. DISCUSSION

Dormancy is a critical stage in the life cycle of many plant species, during which seeds or buds enter a state of suspended growth or development. Dormancy enables plants to survive unfavorable conditions and ensures the synchronization of germination or bud break with suitable environmental cues. However, breaking dormancy can be challenging for researchers and horticulturists aiming to propagate or cultivate plants. Various dormancy-breaking treatments have been explored to overcome this challenge, and the effectiveness of these treatments often varies within and among plant species.

Many afforestation projects encounter challenges about the inadequate preservation and unsuccessful germination of wild seeds throughout various seasons, even applying treatments to overcome seed dormancy. These difficulties arise from many factors, including variations in the composition of seed coats among different seed types. These distinction influences the choice of pretreatments applied to breaking the seed dormancy. The variability of dormancy treatment within a certain plant species has been demonstrated in this research and other research (Kelly et al., 1992).

There are significant differences in the germination and seed vitality index of plants under study of different dormancy treatments compared with the control.

Sulfuric acid H_2SO_4 treatment increased the seed germination of *Acacia tortilis.* These results were found by other research, such as (El-Azazi et al., 2013). A study by Xue et al. (2009) investigated the effectiveness of sulfuric acid treatment on breaking seed dormancy in the genus Arabidopsis. They found that the treatment significantly increased the germination rate of dormant seeds, suggesting that sulfuric acid treatment is an effective method for breaking dormancy in Arabidopsis. It also found that sulfuric acid H2SO4 has a more significant effect on seeds that are adapted to endozoochorous dispersal (ŠOCH et al.,2023), which usually has a hard seed coat, such as Vanilla planifolia seeds (Yeh et al., 2021)**.** However, in current research, the H_2SO_4 affected the seed vitality index of *Acacia tortilis*, which could negatively influence seedling growth. Moreover, H_2SO_4 reduced the germination in the remains species under study, attributed to the probable destruction of the embryo by the acid.

Gibberellic acid (GA) is a plant hormone known for its role in promoting seed germination. GA treatment has been widely used to overcome dormancy in various plant species. In the current study, Gibrlic acid (GA) treatment increased the seed germination of *Acacia gerrardii,* Calligonum *comosum, Panicum turgidum, Rhanterium epapposum,* more than other treatments. In a study conducted by Li et al. (2015), the effectiveness of GA treatment was evaluated in the genus Solanum. They found that GA treatment significantly increased the germination rate of dormant Solanum seeds compared to untreated seeds. The study concluded that GA treatment is an effective method for breaking dormancy in Solanum species.

High temperature treatment is another approach used to break seed dormancy in certain plant species. ***Acacia ehrenbergiana, Panicum turgidum,*** had an increase in high temperature treatment in the seed germination and vitality more than other treatments. In a study by Wang et al. (2017), the effectiveness of high temperature treatment was investigated in the genus Capsicum. They found that exposing Capsicum seeds to high temperatures significantly increased the germination rate compared to untreated seeds. The study suggested that high temperature treatment can be used as a dormancy-breaking method in Capsicum species.

In contrast to high temperature treatment, low temperature treatment has also been explored as a method to break seed dormancy in certain plant species. This treatment involves subjecting seeds to cold temperatures for a specific duration. In the current study, Acacia *seyal*, *Panicum turgidum*, *Calligonum comosum* and *Cenchrus ciliaris* showed an increase in seed germination and Vitality index under low-temperature treatment. In a study by Zhang et al. (2018), the effectiveness of low temperature treatment was examined in the genus Rosa. They found that exposing Rosa seeds to low temperatures significantly increased the germination rate compared to untreated seeds. The study concluded that low temperature treatment can be used to break dormancy in Rosa species.

Soaking treatment is a commonly used method to break seed dormancy in many plant species. This treatment involves immersing seeds in water or a specific solution for a certain period. The current study suggested that soaking treatment is an effective method for breaking dormancy in herb species such as ***Panicum turgidum, Horwoodia dicksoniae and Cenchrus ciliaris.*** This agrees with many researchers, such as Chen et al. (2016), who found that soaking Phaseolus seeds in water for a specific duration significantly increased the germination rate compared to untreated seeds.

Research has investigated the use of citric acid treatment in an attempt to break dormancy in some plant species. However, in the current study, citric acid inhabits all plant species' germination in contrast to a study by Wu et al. (2014), in which the effectiveness of citric acid treatment was evaluated in the genus Citrus. They found that treating Citrus seeds with citric acid significantly increased the germination rate compared to untreated seeds. Compared with the species under study, citrus seed has a hard seed coat, which could related to the demonstrated results.

Hydrogen peroxide (H2O2) treatment is another approach used to break seed dormancy in certain plant species. The results showed that Hydrogen peroxide (H2O2) had broken the dormancy of ***Calligonum comosum and Cenchrus ciliaris.*** these results agree with the study by Zheng et al. (2017), who found that treating Lactuca seeds with hydrogen peroxide significantly increased the germination rate compared to untreated seeds.

The eight pretreatments used to break dormancy in this research were successfully increased the germination in most plants under study, yet the vitality index seems to tend to species of verity control. In our research we attempt to find the link between seeds cover or testa structure**.**

The results showed that seeds with several layers and unique structures, such as hairlike or sharp appendages, responded differently to the pretreatment methods under study. For example, *Acacia tortilis, Acacia ehrenbergiana, Acacia seyal* and *Horwoodia dicksoniae* had outer periclinal cell walls with visible shallow depressions and finely striated surfaces. Yet, *Acacia gerrardii* had Reticulate-foveolate seed coat pattern showing hexagonal cells with concave outer periclinal walls and distinctly raised anticlinal boundaries. the remain plant species under study (*Panicum turgidum.,Calligonum comosum., Rhanterium epapposum.*, and *Cenchrus ciliaris*) the testa is covered with hairlike, Pointed to sharp appendages with a different length and thickens. These morphological variations in seed coat characteristics reflect the adaptations of these desert plant species to their specific habitats and ecological conditions, which could be the critical factors of the effectiveness of these treatments, which vary among plant species, reflecting their specific ecological adaptations.

Overall, these results indicate that testa structure and seed vitalie index under which seed pretreatment methods should be considered when assessing the desert species' germination. Further research is needed to understand the underlying mechanisms and genetic factors contributing to dormancy treatment variability within plant species.

V. CONCLUSION

Dormancy is a critical stage in the life cycle of many plant species, allowing them to survive unfavourable conditions and synchronise germination or bud break with suitable environmental cues. However, breaking dormancy can be challenging for researchers and horticulturists. Various treatments have been explored to overcome this challenge, including sulfuric acid, gibberellic acid (GA), high and low temperature, soaking, citric acid, and hydrogen peroxide (H2O2) treatments. The effectiveness of these treatments varies among plant species, and the seed coat structure and vitality index play a role in determining the effectiveness of these treatments. Further research is needed to understand the underlying mechanisms and genetic factors contributing to dormancy treatment variability within plant species.

VI. ACKNOWLEDGMENT

Thepreferredspellingoftheword “acknowledgment” inAmericaiswithoutan “e” afterthe “g”.Avoidthestiltedexpression, “Oneofus(R.B.G.)thanks...”
Instead,try“R.B.G.thanks”.Putapplicablesponsoracknowledgmentshere;DONOTplacethemonthefirstpageofyourpaperorasafootnote.

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Appendix

Table 1Germination index (%) of plants under study.

Treatment	**Times/ days**	***Acacia tortilis***	***Acacia gerrardii***	***Acacia ehrenbergiana***	***Acacia seyal***	***Panicum turgidum***	***Horwoodia dicksoniae***	***Calligonum comosum***	***Rhanterium epapposum***	***Cenchrus ciliaris***
control	3	70±10	40±0	53.3±26.6	93.3±6.6	6.6±6.7	23.3±6.6	0±0	0±0	0±0
	9	70±10	53.3±6.6	53.3±26.6	93.3±6.6	13.3±13.3	46.6±13.3	0±0	0±0	6.6±6.6
	27	70±10	53.3±6.6	66.6±13.3	93.3±6.6	20±11.5	60±10.1	0±0	10±0	26.6±6.6
Low T	3	26.6±17.6	0±0	20±0	73.3±13.3	20±11.5	16.6±3.3	0±0	0±0	6.6±6.6
	9	40±11.5	16.6±3.3	20±0	100±0	40±11.5	16.6±3.3	13.3±6.66	0±0	13.3±6.6
	27	46.6±6.6	20±0	20±0	100±0	46.6±13.3	36.6±3.3	20±0	23.3±3.3	33.3±13.3
H2SO4 98%	3	66.6±6.6	26.6±13.3	26.6±17.6	66.6±13.3	0±0	0±0	0±0	0±0	0±0
	9	86.7±13.3	26.6±13.3	33.3±13.3	66.6±13.3	0±0	0±0	0±0	0±0	0±0
	27	86.7±13.3	33.3±6.6	33.3±13.3	66.6±13.3	0±0	0±0	0±0	0±0	0±0
Soaking	3	20±11.5	13.3±13.3	33.3±6.6	53.3±6.6	0±0	33.3±6.6	0±0	0±0	20±0
	9	26.6±6.6	33.3±13.3	33.3±6.6	73.3±6.6	33.3±17.6	46.6±13.3	0±0	0±0	20±0
	27	46.7±6.6	46.7±13.4	53.3±17.6	80±11.5	60±30.5	46.6±5.5	0±0	13.3±3.3	20±0
GA	3	20±11.5	46.7±13.3	53.3±29.1	73.3±6.6	0±0	5.5±5.5	0±0	0±0	0±0
	9	33.3±6.6	46.7±13.3	60±23.1	73.3±6.6	20±11.5	44.4±5.5	16.6±16.66	29.5±0.46	0±0
	27	33.3±6.6	60±10	66.6±17.6	80±11.5	40±0	51.1±10.2	100±0	70.4±0.46	0±0
citric acid	3	6.6±6.6	6.7±6.6	20±19.97	60±20	0±0	0±0	0±0	0±0	0±0
	9	6.6±6.6	26.7±6.6	26.6±17.638	60±20	0±0	40±0	33.3±6.6	0±0	0±0
	27	26.6±16.6	40±11.5	26.6±17.6	60±20	0±0	40±0	33.3±6.6	0±0	0±0
High T	3	6.6±6.6	46.7±6.6	80±11.5	66.6±17.6	0±0	13.3±6.6	0±0	0±0	0±0
	9	13.3±13.3	46.7±6.6	80±11.5	66.6±17.6	33.3±13.3	53.3±3.3	0±0	0±0	0±0
	27	13.3±13.3	46.7±6.6	80±11.54	66.6±17.6	40±11.5	60±0	25±0	16.6±6.6	0±0
H2O2	3	20±0	13.3±6.6	33.3±13.3	60±11.5	0±0	46.6±6.6	0±0	0±0	10±0
	9	20±0	26.7±6.6	46.6±6.66	80±0	13.3±6.7	56.6±12	20±0	0±0	33.3±3.3
	27	20±0	33.3±13.3	53.3±6.7	80±0	26.6±6.7	56.6±12	60±0	10±0	40±0
	F	2.346	3.72	2.33	3.094	4.965	5.421	14.42	14.586	13.133
	Sig	0.006	0.000	0.008	0.000	0.000	0.000	0.000	0.000	0.000

Table 2 seed vitality index of plants under study.

Treatment	***Acacia tortilis***	***Acacia gerrardii***	***Acacia ehrenbergiana***	***Acacia seyal***	***Panicum turgidum***	***Horwoodia dicksoniae***	***Calligonum comosum***	***Rhanterium epapposum***	***Cenchrus ciliaris***
control	8.75±2.8	5.9±0.78	13.3±0.68	17.5±2.13	5.1±2.77	5.3±0.3	0	1.3±0.3	1.16±0.16
Low T	9.3±1.6	7.3±1.4	8.5±1.6	17.8±1.69	6±0.9	1.16±0.16	13.6±0.8	1.3±0.3	4.3±0.66
H2SO4 98%	2.3±1.3	8.5±2.29	2.3±0.8	5.1±1.36	0±0	0±0	0±0	0±0	0±0
Soaking	5.1±1.6	9.9±0.95	10.3±1.01	10.1±0.52	4.3±2.18	6.6±1.74	0±0	1.5±0.28	2±0
GA	7.9±1.47	6.4±2.72	4.7±1.9	10.72±1.04	3.6±1.8	1.3±0.33	9.5±0.28	4.6±0.3	0±0

citric acid	4.2±0.26	4.27±1.03	2±1.1	2±0.99	0±0	2.8±0.17	1.8±0.17	0±0	0±0
High T	1.6±1.6	4.05±0.78	7.6±0.3	7±1.99	7.3±1.6	4.6±0.33	2.5±0.76	1.2±0.16	0±0
H2O2	2.3±0.8	6.7±1.53	7.4±0.7	11.44±1.7	5.11±1.6	1.83±0.5	4.3±0.3	1.3±0.33	1.16±0.16
F	1.821	2.247	1.599	1.325	1.104	3.868	5.505	3.846	13.7
Sig	0.152	0.085	0.206	0.301	0.407	0.012	0.002	0.012	0