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The effect of different priming methods in breaking seed dormancy in date palm (*Phoenix dactylifera L.*)

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ABSTRACT

Seed dormancy is a phenomenon that prevents seeds from growing during adverse conditions. A number of factors may be responsible for this phenomenon, but one very common reason is the hardness of the seed coat as in the case of Date palm. This research was conducted to determine the effect of different priming methods on the rate of germination of date palm seeds. The treatments include cold water, hot water, H_2SO_4 and control in a cross randomized design. For the cold water treatment seeds were soaked for either 24, 48 or 72 hours; for the hot water treatment they were soaked for either 5, 10, or 15 minutes; and for the acid treatment they were soaked in 25 %, 50 % or 100 % of H2SO4 for 5 minutes. Twenty (20) seeds were selected for each treatment to carry out the germination experiment using moist absorbent paper. Data for germination rate was collected at 1, 2 and 3 weeks after planting (WAP). An optimal germination rate of 83% was observed at 3 WAP for the hot water treatment for 5 minutes. From this research, it can be concluded that priming generally increased the rate of germination of date palm seeds.

Contribution/ Originality: The conditions used for priming date palm seeds and the use of moist absorbent paper as a growth medium, makes it different from other works that have been carried out in this area. Hot water treatment for 5 minutes had the highest rate of germination of 83% after three weeks.

1. INTRODUCTION

The monocotyledonous, woody, perennial date palm (Phoenix dactylifera L.), a common crop around the world, has been referred to as a rich source of nutrients [1-3]. It contains 6.5-11.5 % total dietary fibers, 1 % fat, 2 % protein, 2 % ash and 1-2 % phenolic antioxidants [4]. Additionally, it is abundant in minerals, vitamins B complex, including thiamine (B1), riboflavin (B2), niacin (B3), pantothenic (B5), pyridoxine (B6), and folate, as well as carbohydrates, dietary fibers, proteins, and minerals [1, 5, 6]. About 6000 years ago, the germination and plantation of date palm seed was the first step to reach the full domestication of this plant [7]. Despite the enormous advantages that growing date palms can provide, cultivating them has remained tough due to the difficulties of their establishment when they

are propagated from seeds [8, 9]. According to certain statistics, the majority of palm seed germination rates are subpar. While viable Date palm seeds can germinate between 14 and 21 days under optimal circumstances, dormancy issues can occasionally lead these viable date seeds to take up to 100 days to germinate [8, 9]. This phenomenon conflicts with the planting schedule and hampers the rapid and uniform sprouting of seedlings [10].

The phenomenon of seed dormancy is not fully understood by scientist despite the advances in seed biology [10]. Seed dormancy is an adaptation of plants that prevents their seeds from germinating during adverse environmental conditions that will usually result in poor rates of survival of seedlings [11]. Seed dormancy could make that seeds do not sprout even when the conditions necessary for germination are relatively favourable [12]. This phenomenon has been described in classical literature as a negative developmental state where a viable seed fails to germinate despite appearing to have favorable environmental conditions [13]. Dormancy is typically linked to innate elements such the integument's hardness and impermeability to gases and liquids, immature embryos, inhibitors, and abiotic variables including substrate, temperature, light, and humidity [14]. Baskin and Baskin [15] had reported that there are different ways of breaking seed dormancy. Nature also uses abrasion (physically rubbing the seed coat to make it thinner so that water and gases can permeate into the seed), animals ingesting and eventually excreting seeds, freezing and thawing circumstances, fire treatment, and other processes to break dormancy [9]. Similar to this, other traditional techniques for removing seeds from dormancy include stratification, scarification, treating seeds with chemicals like acids, and water soaking of seeds [16]. A lot of research has been done exploring various methods of breaking seed dormancy in date palm seeds, but there is still room for improvement, hence this work.

2. MATERIALS AND METHODS

2.1. Sample Collection

Dried fruits of date palm were obtained from the fruit market in front of the main gate of the Kogi State University Campus, Anyigba, Kogi State, Nigeria (7o29'0.67901"N, 7o10'44.60015"E).

2.2. Sample Preparation

Seeds were removed from the date palm fruits using a nutcracker, they were surface sterilized with 1% Sodium hypochlorite (bleach), rinsed twice with distilled water.

2.3. Seed Viability Test

Seeds were soaked in a conical flask (1000ml) of tap water, those that floated were considered nonviable and were discarded, while those that sank were considered viable and used for the experiment.

2.4. Experimental Design

The experiment was carried out in a cross randomized design (CRD). The seeds were subjected to 3 groups of treatment (cold water, hot water and acid). For the cold water treatment, seeds were soaked in tap water for 24, 48 and 72 hours respectively. For the hot water treatment, seeds were soaked in boiled water (100°C) for 5, 10 and 15 minutes respectively. For the acid treatment, seeds were soaked in various concentrations (25, 50 and 100 % respectively) of Tetraoxosulphate (vi) acid (H_2SO_4) for 5 minutes. The control was left without pre-planting treatment of any form. Experiments were carried out in triplicates.

2.5. Germination Experiment

Twenty (20) seeds were selected from each treatment. The seeds were arranged in five (5) rows with the hilum facing upwards, on double absorbent papers moistened with 10 ml of distilled water, placed in a rectangular plastic container. The seeds were covered with another double absorbent papers and moistened again with 10 ml of water.

The set up was moistened with 20 ml of water daily throughout the period of the experiment. Data for germination rate was collected at 1, 2 and 3 weeks after planting (WAP). Germination rate was calculated using:

$$\text{Germination Rate (\%)} = \frac{\text{Number of germinated seeds at time t}}{\text{Number of planted seeds at time t}} \times 100$$

2.6. Statistical Analysis

Data collected were subjected to analysis of variance (ANOVA) using the statistical software SPSS version 21 (IBM Machines). Significant means ($p<0.05$) were separated using Duncan New Multiple Range Test (DNMRT). Values were expressed as Mean ± S.E.M (Standard Error of Mean).

3. RESULTS

Table 1 shows the effect of cold water treatment on date palm seeds. Results revealed that there was a significant increase in the percentage germination with time of soaking. At 1 WAP there was no significant difference between cold water treatment at 24 hours and the control, there was however a significant difference between the 48 hour treatment and 72 hour treatment compared to the control. The same trend also followed for 2 and 3 WAP. The 72hour treatment showed the highest germination rate in the cold water treatment at either 1, 2 or 3 WAP.

Table 1. Effect of cold water on the germination rate (%) of date palm seeds.

Treatment	1 WAP	2 WAP	3 WAP
Control	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	3.33 ± 3.33^{a}
24Hours	0.00 ± 0.00^{a}	3.33 ± 3.33^{a}	16.67 ± 6.67^{a}
48Hours	10.00 ± 0.00^{b}	33.33 ± 3.33^{b}	40.00 ± 5.77^{b}
72Hours	16.67 ± 3.33^{c}	56.67 ± 3.33^{c}	56.67 ± 3.33^{c}

Note: Mean ± SEM; value with different superscript in the same column are significantly different at $p<0.05$.

Table 2 shows the effects of the hot water treatment on date palm seeds. At 1 WAP, the 5 minutes treatment had a significantly higher germination percentage than the 10 minutes treatment. The same trend followed for 2 WAP and 3 WAP. The 5 minute treatment had a very highest germination percentage of 83.33%.

Table 2. Effect of hot water on the germination rate (%) of date palm seeds.

Treatment	1 WAP	2 WAP	3 WAP
Control	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	3.33 ± 3.33^{a}
5Min	26.67 ± 3.33^{c}	60.00 ± 5.77^{c}	83.33 ± 3.33^{c}
10Min	6.67 ± 3.33^{b}	16.67 ± 3.33^{b}	20.00 ± 5.77^{b}
15Min	0.00 ± 0.00^{a}	13.33 ± 3.33^{b}	20.00 ± 5.77^{b}

Note: Mean ± SEM; value with different superscript in the same column are significantly different at $p<0.05$.

Table 3. Effect of acid (H_2SO_4) on the germination rate (%) of date palm seeds.

Treatment	1 WAP	2 WAP	3 WAP
Control	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	3.33 ± 3.33^{a}
25% Conc.	6.67 ± 3.33^{a}	30.00 ± 5.77^{b}	36.67 ± 3.33^{b}
50% Conc.	23.33 ± 3.33^{b}	36.67 ± 3.33^{b}	56.67 ± 3.33^{c}
100% Conc.	0.00 ± 0.00^{a}	3.33 ± 3.33^{a}	3.33 ± 3.33^{a}

Note: Mean ± SEM; value with different superscript in the same column are significantly different at $p<0.05$.

Table 3 shows the effect of H_2SO_4 on date palm seeds. At 1 WAP, there was no significant difference in the germination percentage of the control, 25 % and 100 % treatments, but they were significantly different from that of the 50 % treatment. At 2 WAP, the germination percentage of 25 % and 50 % treatments were not significantly different from each other but they were significantly different from that of 100 %. At 3 WAP, there was a significance

treatments were all significantly different from each other with the 100 % not different from the control. The 50% treatment at 3 WAP had the highest germination percentage of 56.67%.

Table 4 compares the best performance of the 3 treatments at 3 WAP against the control. There was no significant difference between the cold water treatment at 72hours and Acid treatment at 50 %. The Hot Water treatment had the highest percentage of germination of 83.33%.

Table 4. Evaluation of the highest germination rates from the three treatments a 3 WAP.

Treatment	Germination %
Control	3.33 ± 3.33^{a}
Cold water (72Hours)	56.67 ± 3.33^{b}
Hot water (5Mins)	83.33 ± 3.33^{c}
Acid (50% H_2SO_4)	56.67 ± 3.33^{b}

Note: Mean ± SEM; value with different superscript in the same column are significantly different at $p<0.05$.

4. DISCUSSION

Findings from this research revealed that all the methods used in breaking seed dormancy had a significant effect on the rate of germination of *P. dactylifera* compared to the control. Pretreated seeds generally sprouted faster and had a higher percentage germination than those not treated. The dormancy of *P. dactylifera* arises from the toughness of the seed coat, and the increase in the rate of germination after different priming methods could be basically attributed to the removal of the seed cuticle and tenderization of the hard seed coat to enhance sprouting.

Treatment of the seeds with cold water resulted in the increase in the rate of germination. This was consistent with the results of Muhammad, et al. [17] and Habila, et al. [9], which revealed a similar gradual increase in date palm germination rate with increase in treatment time. The increase in the rate of germination observed may be due to the imbibition of water by the seeds with time. Imbibition activates dormant metabolic processes in the seeds such as the hydrolysis of the reserved food in the seeds into simpler forms the embryo can absorb for germination [18].

Treatment of seeds with hot water also resulted in an increased germination percentage. Other authors have also reported similar results [19, 20]. It has been suggested that the impact of hot water on the date palm seed coat may have caused this outcome, by dissolving the chemical linkages thought to be responsible for seed dormancy. A further improvement of the germination rate by hot water may have been brought about by the soaking effect of the water itself in addition to the increased temperature [21].

The treatment of seeds with H_2SO_4 equally resulted in an increase in the percentage of germination. This is consistent with the report of Kuldeep, et al. [22] and Dada, et al. [23]. The mechanism responsible for the increase in germination rate with the treatment of H_2SO_4 may be due to the fact that, the acid disintegrates the hard seed coat resulting in imbibition and oxygen adsorption, which in turn leads to germination of the embryo [24]. Another possible reason for the effect of acid on the seeds is due to the fact that it alters the cell pH of the seeds, which in turn activates the developmental process within the seed [25].

The poor percentage germination rate observed in some treatments (such as Hot Water at 15 minutes and 100 % Acid) could have resulted from the severity of the treatment on the seed embryo, causing mortality or sterility. This agrees with the findings of several authors [9, 17, 26].

5. CONCLUSIONS

This study revealed that pretreatment (cold water, hot water and acid) generally enhanced the breaking of seed dormancy in date palm seeds, leading to a faster rate of sprouting and higher percentage germination. Among the various methods taken into account in this study, soaking seeds in boiling water for 5 minutes had the highest germination percentage of 83% at 3 WAP. This may be recommended to date palm farmers to assure continuous seedling emergence and increased seedling growth.

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