

# EFFECTS OF HYDRO-PRIMING AND SODIUM CHLORIDE CONCENTRATIONS ON THE GERMINATION OF *Zizyphus mauritiana* SEEDS

Adelani, D. O.,\* Maisamari, I. J. and Oloyede, I.

Federal College of Forestry Mechanization, Afaka, Kaduna

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## Abstract

Two experiments were conducted in the nursery of Federal College of Forestry Mechanization, Afaka Kaduna to assess the effect of hydropriming on the germination of *Zizyphus mauritiana* seeds with hard seed coat. The first experiment was laid down in a completely randomized design with four replicates. The second employed the use of split-plot experimental design with four replications to investigate the effect of NaCl concentrations (0.2, 0.3, 0.4 and 0.5ppm) and halopriming hours (0, 12, 24, 36 and 72hours) on the germination of *Z. mauritiana* seeds. Results revealed that highest germination percentage value of 68.75% recorded for *Z. mauritiana* seeds soaked in water for 6hours was significantly ( $P<0.05$ ) higher than that of 0 hours. The least germination time of 73.55days recorded for seeds treated in water for 6hours was significantly ( $P<0.05$ ) lower than that of 0 hour. Irrespective of treatment time, germination percentage values of seeds treated in 0.2, 0.3, 0.4 and 0.5ppm ranged from 35 to 44.50%. Highest germination percentage value of 44.25% was recorded for seeds treated in 0.3 and 0.5ppm of NaCl. The least mean germination time of 21.07days was recorded for seeds treated in 0.5ppm concentration of NaCl. Irrespective of concentration of NaCl, germination percentage value of 54.38% recorded for seeds treated for 12hours was significantly ( $P<0.05$ ) higher than that of control. The least mean germination percentage value of 20.05days recorded for treatment time of 36hours was lower than that of 24hours (24.32days). Interactive result showed that 81.28% recorded for *Z. mauritiana* seeds treated in 0.5ppm for 12hours was significantly ( $P<0.05$ ) higher than that of 72hours (25%) and was recommended for its mass production for agroforestry programmes.

**Keywords:** Germination, Sodium chloride, Hydropriming, Halopriming, Mean germination time.

\*adelani.olusegun@yahoo.com

## Introduction

*Zizyphus mauritiana* belongs to the Rhamnaceae family. Of the well-know species of the genus *Zizyphus* ber, *Z. mauritiana* is the most common in tropical and sub-tropical regions, while *Z. jujube* is well known in temperate part of the world. It is called Magarya, Jali, Kusulu in Hausa, Fulani and Kanuri (Keay, 1989). *Z. mauritiana* has become naturalized in tropical African, Iran, Syria, Sri lanka and part of the Mediterranean (Kaarira, 1998). The fruit is eaten raw, nutritious and rich in vitamin C. Its vitamin C is second to guava and much higher than that of citrus or apples. The fruit are used in Chinese and Korean traditional medicines where they are believed it alleviates stress.

In Indian, it grows best on sandy, loam, neutral or slightly alkaline soil (Morton, 1987). It is used in jam making, food supplements, manufacturing of candy. It requires a deep soil, fresh, soft, siliceous- calcarous nature or limestone-clay-silica-clay with pH between 5.5 and 7.8 (Janick and paul, 2008). This species in northern India yields 80 to 200kg of fresh fruit/tree/year when the trees are in their prime bearing age of 10-20years. It contains 20-30% sugar, up to 2.5% protein and 12.8% carbohydrates. The leaves are readily eaten by camels, cattle and goats and are considered nutritious. In India and Queensland, the flowers are rated as minor sources of nectar for honey bees. The honey is light and of fair flavours (USDA, 2013).

Its timber is hard, strong, fine-grained, fine-textured, tough, durable and reddish in colour. It has been used in lining wells, constructions and charcoal making with heat content of almost 4,900kcal per kg. It is used to treat irritability, insomnia and heart palpitations, fever, indigestion and biliousness, nausea, vomiting and abdominal pains in pregnancy, diarrhoea, wounds, rheumatism, liver troubles, asthma, dysentery, relieve gingivitis, sores and eye diseases (Gultekin, 2007; USDA, 2013). In spite of the economic importance of *Z. mauritiana* tree, the rate of its domestication is low. The seeds of *Z. spina-christi* possess hard woody seed-coat which hampers germination (Assareh, 2008; Sadeghi *et al.*, 2011). *Z. mauritiana* seeds have hard seed coats that restrict germination (Janick and Paul, 2008). Seed of *Z. mauritiana* may remain viable for two and half years without germinations in the absence of presowing treatments.

Seed dormancy is regarded as the failure of an intact viable seed to complete germination under favourable condition (Ajiboye, 2010). The dormancy of the seed of *Z. mauritiana* poses a serious problem to its domestication rate. The dormancy of the seeds as well as dearth of quantified information on simple and inexpensive modern techniques of overcoming dormancy such as hydro and halo priming have limited the domestication rate of *Z. mauritiana*. In light of this, this research investigates the germination potentials of seed of *Z. mauritiana* as influenced by hydro and halo priming treatments.

### Experimental Site

The research was conducted in the nursery of the Federal College of Forestry Mechanization, Afaka, Kaduna. The College is located in the Northern Guinea Savannah ecological zones of Nigeria. The Garmin GPS 72 model was used to determine latitude  $10^{\circ} 35^1$  and  $10^{\circ} 34^1$  and longitude  $7^{\circ} 21^1$  and  $7^{\circ} 20^1$ . Rainfall is approximately 1000mm annually with the lowest monthly relative humidity averaging 29%. The vegetation is open woodland with tall broad leave trees, usually with small holes and broad leaves (Otegbeye *et al.*, 2001).

### Fruit Collection and Materials

The fruits were sourced from the mother tree in the forest around Trial Afforestation Research Station, Afaka, Kaduna. The seeds were extracted from the fruits and air dried.

The randomly picked seed samples were cut open to assess the embryo through cutting method (Schmidt, 2000). The sand was collected from the College dam and sterilized in the Biological Laboratory of the Federal College of Forestry Mechanization, Afaka, Kaduna at 160°C for 24hours. The polypots of 20x5x5cm<sup>3</sup> were filled with sterilized sand in the nursery. Potassium nitrate and sodium chloride were collected from Chemistry Laboratory of the College.

### **Experimental Procedure**

#### **Experiment 1:** Effect of Hydropriming on Germination of *Z. mauritiana* Seeds.

The effect of hydropriming on germination of *Z. mauritiana* seeds was assessed using a completely randomized design with four (4) replications. Four (4) replicates were soaked in different times (0, 6, 8, 12 and 14 hrs). 1000 seeds of *Z. mauritiana* were extracted from the fruits. The seeds were washed and air dried. 10 seeds represented a replicate. Four (4) replicates each was soaked in water for 0, 6, 8, 12 and 14 hours. The soaked seeds were also dried back to the initial moisture content. The temperature of the water during priming was 28°C. Stirring or bubbling was done to ensure uniform treatment and aeration. After priming, seeds were removed, washed, air dried for 30 minutes and treated with fungicides (Vinclozolin). Treated seeds were planted in 4cm depth of the sterilized sand and 80ml of water per seed was applied regularly at two days interval. A seed was considered germinated when the radicle was able to break open the seed coat and at the sight of plumule emergence.

#### **Experiment 2:** Effect of Sodium Chloride on Germination of *Z. mauritiana* Seeds.

The effect of concentrations and treatment times of sodium chloride on germination of *Z. mauritiana* seeds was assessed using a split-plot design with four (4) replications. Four (4) concentrations of sodium chloride (0.2, 0.3, 0.4 and 0.5ppm) made up the main plot and different times of immersion (0, 12, 24, 36 and 72hrs) constituted the sub-plot treatment. 1000 of *Z. mauritiana* seeds were extracted from the fruits. The seeds were washed and air dried. 10 seeds represented a replicate. Four replicates each was soaked in percentage solutions of sodium chloride (0, 0.2, 0.3, 0.4 and 0.5ppm) and at different times (0, 12, 24, 36 and 72 hrs). Stirring or bubbling was done to ensure uniform treatment and aeration. After each treatment, the seeds were removed, washed air dried for 30 minutes and treated with fungicide (Vinclozolin). Treated seeds were planted in 4cm depth of the sterilized sand and 80ml of water per each seed was applied at two days interval. Seeds that were not soaked in the sodium chloride served as control. A seed was considered germinated when the radicle was able to break open the seed coat and at the sight of plumule emergence.

### **Germination percentage and Mean Germination Time**

Germination percentage was computed using the formula:

Germination percentage

$$= \frac{\text{Total seed germination} \times 100}{\text{Total seed sown}}$$

Mean germination time was calculated using the formula:

$$\text{MGT} = \frac{\sum(fx)}{\sum X}$$

Where x is the number of newly germination seed on each day and f is the number of days, after seeds have set to germinate.  $\sum X$  is the total number of seeds that germinated at the end of the experiment. Germination percentage and mean germination time was recorded at two (2) days interval for 8 weeks.

### Data Analysis

The data was collected on seed germination and mean germination time and was subjected to analysis of variance ANOVA. Using SAS (2003) software, mean separation at 5% significant level of probability was carried out with use of least significant Difference (LSD).

### Results and Discussion

#### Effect of Hydropriming on the Germination of *Z mauritiana* Seeds

The result of the effect of hydropriming on the germination of *Z mauritiana* seeds is presented in Table 1. Germination percentage values of 37.50, 68.75, 55.00, 53.75 and 50.00% were recorded for *Z mauritiana* seeds treated for 0, 6, 8, 12 and 14 hours respectively. Highest value of 68.75 was recorded in *Z mauritiana* seeds hydroprimed for 6 hours. Caseiro *et al.* (2004) found out that hydropriming was the most effective method for improving seed germination in the onion, especially when the seeds were hydrated for 96 hours compared with 48 hours. Exposing seeds of plant species to appropriate time of hydropriming allowed seeds to imbibe water for a longer time and went through the first stage of germination without protrusion of radicle (Kaya *et al.*; 2006). Positive effects of seed priming on seed invigoration depend on priming duration (Ashraf and Foolad, 2005). Mean germination time of 94.5, 73.55, 79.92, 74.15 and 80.5days were recorded for 0, 6, 8, 12 and 14hours respectively. The least value of 73.55days was recorded in *Z.mauritiana* seeds in water for 6 hours.

**Table 1: Effect of Hydropriming on the Germination of *Z. mauritiana* Seeds**

Hydropriming (Hours)	Mean germination time	Percentage germination (%)
0	94.5 <sup>a</sup>	37.50 <sup>b</sup>
6	73.55 <sup>b</sup>	68.75 <sup>a</sup>
8	79.92 <sup>b</sup>	55.00 <sup>a</sup>
12	74.15 <sup>b</sup>	53.75 <sup>a</sup>
14	80.5 <sup>a</sup>	50.00 <sup>a</sup>
SE <sub>±</sub>	14.0	13.44

\*Means in the same column having different superscript are significantly (P<0.05) different

#### **Effect of Concentrations and Treatment Times of Sodium Chloride on the Germination of *Z. mauritiana* seeds**

The result of the effect of concentrations and treatment times of sodium chloride on the germination of *Z. mauritiana* seeds is presented in Table 2. Irrespective of treatment times, germination percentage values of 35%, 44.25%, 40.50% and 44.25% were recorded for 0.2, 0.3, 0.4 and 0.5ppm concentration of sodium chloride. This is not in consonance with the report of Mariem, *et al.* (2013) who stated that increasing NaCl level led to the reductions in germination percentage for all cultivars of *Coriandrum sativum* (Syrian cv, Tumision cv, Egyptian cv, Algerian cv) study). This germination reduction can be attributed to prevention of water uptake created by the salinity condition. This can be also be due to the toxic effects of ions of the salt such as K<sup>+</sup> and NO<sub>3</sub><sup>-</sup>. Similar result was obtained by Khajeh Hosseini *et al.* (2013) on the effect of NaCl on the germination of soybean. Other studies on many crops such as melon (Sivritepe, *et al.*; 2003, canola (Farhondi *et al.*; 2007), pepper (Khan *et al.*, 2009, tall fescue (Tilaki *et al.*, 2010), sun flower (Bajehbaj, 2010) and pot Marigold (Sedghi *et al.*, 2010) have equally reported contrary to findings to that observed in this study. Several investigators had reported the efficiency of priming with salts, on the other hand, earlier reports on argan (Reda Tazi *et al.* 2001) and cereals (Ben Naceur *et al.* 2001); chickpea (Al-mutawa, 2003) and barley (Kadiri *et al.* 2009) reported the unfavourable impact of salinity in priming.

Irrespective of concentrations of sodium chloride, germination percentage values of 22.19%, 54.38%, 48.13%, 40.00% and 40.31% were recorded for *Z. mauritiana* seeds treated for 0, 12, 24, 36 and 72 hours respectively. On the other hand, Akinola *et al.* (2000) reported that a higher duration of exposure of seed treatment resulted in higher cumulative germination in wild sunflower and seeds always germinated better in NaCl than in Polyethylene glycol at equivalent water potentials. This is in line with earlier observations made for soya bean by Khajeh- Hosseini *et al.* (2003). This result may be due to the uptake of Na<sup>+</sup> and Cl<sup>-</sup> ions by the seed, maintaining a water potential gradient

allowing water uptake during seed germination. These results are in agreement with those of Murillo-Amador *et al.* (2000) in cowpea.

**Table 2: Effect of Concentrations and Treatment Times of Sodium Chlorine on the Germination of *Z. mauritiana* seeds**

Percent Nacl Conc. (ppm)	Germination Percent (%)	Mean Germination Time (days)	Treatment Time (Hour)	Germination Percent (%)	Mean Germination Time (days)
-	-	-	0	22.19 <sup>b</sup>	23.02 <sup>a</sup>
0.2	35.00 <sup>b</sup>	21.99 <sup>a</sup>	12	54.38 <sup>a</sup>	22.63 <sup>a</sup>
0.3	44.25 <sup>a</sup>	22.76 <sup>a</sup>	24	48.13 <sup>b</sup>	24.32 <sup>a</sup>
0.4	40.50 <sup>a</sup>	23.59 <sup>a</sup>	36	40.00 <sup>b</sup>	20.05 <sup>b</sup>
0.5	44.25 <sup>a</sup>	21.07 <sup>a</sup>	72	40.31 <sup>b</sup>	21.73 <sup>a</sup>

\*Means in the same column having different superscript are significantly (P<0.05) different.

#### **Interactive Effect of Concentrations and Treatment Times of Nacl on the Germination of *Z. mauritiana* seeds**

The result of interactive effect of concentrations and treatment times of Nacl on the germination of *Z. mauritiana* seeds is presented in Table 3. Germination percentage values of 13.75%, 68.75%, 36.25% and 20% were recorded for *Z. mauritiana* seeds treated in 0.2ppm of Nacl concentration for 0, 12, 24, 36 and 72 hours respectively. Germination percentage values of 17.5%, 40.00%, 78.75%, 43.75% and 41.25% were recorded for *Z. mauritiana* seeds soaked in 0.3ppm concentration of Nacl for 0, 12, 24, 36 and 72 hours respectively. Germination percentage values of 27.5%, 27.5%, 35%, 37.50% and 75% were recorded for *Z. mauritiana* seeds soaked in 0.4ppm concentration of Nacl for 0, 12, 24, 36 and 72 hours respectively. *Z. mauritiana* seeds soaked in 0.5ppm concentration of Nacl had germination percentage values of 30%, 81.25%, 42.50%, 42.50% and 25% for 0, 12, 24, 36 and 72 hours respectively. Highest value of 81.28% was recorded for *Z. mauritiana* seeds treated in 0.5ppm concentration of Nacl for 12 hours. According to Fredj *et al.* (2013), the best germination percentage of Coriander (*Coriandrum sativum*) was obtained by soaking seeds in Nacl at 4gL<sup>-1</sup> for 12 hours.

**Table 3: Interactive Effect of Concentrations and Treatment Times NaCl on the Germination of the *Z.mauritiana* Seeds**

Nacl Conc	Treatment Times				
	0	12	24	36	72
0.2	13.75 <sup>c</sup>	68.75 <sup>a</sup>	36.25 <sup>b</sup>	36.25 <sup>b</sup>	20.00 <sup>c</sup>
0.3	17.50 <sup>c</sup>	40.00 <sup>b</sup>	78.75 <sup>a</sup>	43.75 <sup>b</sup>	41.25 <sup>b</sup>
0.4	27.50 <sup>b</sup>	27.50 <sup>b</sup>	35.00 <sup>b</sup>	37.50 <sup>b</sup>	75.00 <sup>a</sup>
0.5	30.00 <sup>c</sup>	81.28 <sup>a</sup>	42.50 <sup>b</sup>	42.50 <sup>b</sup>	25.00 <sup>c</sup>

\*Means in the same rows having different superscript are significantly (P<0.05) different

#### **Interactive Effect of Mean Germination Time of Concentrations and Treatment Times of Nacl on the Germination of *Z. mauritiana* Seeds**

Germination percentage values of 24.21%, 21.73%, 24.35%, 20.75% and 18.9% were recorded for *Z. mauritiana* seeds soaked in 0.2ppm concentration of Nacl for 0, 12, 24, 36 and 72 hours respectively. Germination percentage values of 15.17%, 23.92%, 25.77%, 23.73% and 25.23% were recorded for *Z. mauritiana* seeds soaked in 0.3ppm concentration of Nacl for 0, 12, 24, 36 and 72 hours respectively. *Z. mauritiana* seeds treated in 0.4ppm concentration of Nacl had the germination percentage values of 28.42%, 24.11%, 25.02%, 18.56% and 21.85% for 0, 12, 24, 36 and 72 hours respectively. *Z. mauritiana* seeds soaked in 0.5ppm of Nacl for 0, 12, 24, 36 and 72 hours had germination percentage values of 24.13%, 20.78%, 22.16%, 17.14% and 20.94%. Least germination percentage of 15.17days was recorded for *Z. mauritiana* seeds soaked in 0.3ppm for 0hour. Haloprimed seeds had higher Germination Index as compared with untreated seeds due to Nacl and PEG conditions (Abbasdokht *et al.*, 2012). Takhti and Shekafande (2012) found that germination rate of hydro-primed and osmo-primed (different concentration of Nacl and Zns) seeds was higher than that of control (seeds without treatment) in thorn jujube (*Zizyphus spina-christi*).

**Table 4: Interactive Effect of Mean Germination Time of Concentrations and Treatment Times of Nacl on the Germination of *Z. mauritiana* Seeds**

Conc Nacl (ppm)	Treatment times (hours)				
	0	12	24	36	72
0.2	24.21 <sup>a</sup>	21.73 <sup>a</sup>	24.35 <sup>a</sup>	20.75 <sup>a</sup>	18.9 <sup>a</sup>
0.3	15.17 <sup>b</sup>	23.92 <sup>a</sup>	25.77 <sup>a</sup>	23.73 <sup>a</sup>	25.23 <sup>a</sup>
0.4	28.42 <sup>a</sup>	24.11 <sup>a</sup>	25.02 <sup>a</sup>	18.56 <sup>b</sup>	21.85 <sup>a</sup>
0.5	24.31 <sup>a</sup>	20.78 <sup>a</sup>	22.16 <sup>a</sup>	17.14 <sup>b</sup>	20.94 <sup>a</sup>
SE+	2.78	2.78	2.78	2.78	2.78

\*Means in the same rows having different superscript are significantly (P<0.05) different.

## Conclusion

The experiment revealed that the highest value of 68.75% was recorded in *Z. mauritiana* seeds hydroprimed for 6 hours. The least mean germination percentage value of 20.05days recorded for treatment time of 36hours was lower than that of 24hours (24.32). For maximum germination percentage value to be obtained for agroforestry programmes, *Z. mauritiana* seeds need to be treated in 0.5ppm for 12hours.

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