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Effects of Hydro-Priming and Sodium Chloride Concentrations on the Germination of *Zizyphus mauritiana* Seeds

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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 hydro and halo priming 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 sodium chloride concentrations (0.2, 0.3, 0.4 and 0.5ppm) and treatment periods (0, 12, 24, 36 and 72hours) on the germination of *Z. mauritiana* seeds. Results revealed that a significant decrease in percentage germination was recorded with the increasing hydro priming hours. Highest germination percentage value of 68.75% was recorded for seeds soaked in water for 6hours. A significant decrease in percentage germination was recorded with increasing treatment period of soaking seeds in NaCl from 12 to 36 hours. The percentage germination ranged between 22.19% - 54.38% for 0 and 72 hours of seed soaking. The percentage germination ranged between 13.75% - 81.28% for seeds soaked in 0.2 and 0.5ppm concentrations of NaCl. The least mean germination time of 20.05days was recorded for treatment time of 36hours. Interaction result showed that 81.28% recorded for seeds treated in 0.5ppm for 12hours was significantly ($P<0.05$) higher than that of 72hours (25%) and is recommended for its mass seedling production for agro-forestry programmes.

Key words: Treatment periods, Concentration, Halo-priming, Mean germination time, Agroforestry.

Introduction

Zizyphus mauritiana belongs to the Rhamnaceae family. Of the well-known 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 fruits are used in Chinese and Korean traditional medicines where they are believed to alleviate stress.

In India, it grows best on sandy, loam, neutral or slightly alkaline soil (Morton, 1987). It is used in jam making, food supplements and manufacturing of candy. It requires a deep soil, fresh, soft, siliceous- calcarcous 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 200 kg of fresh fruit/tree/year when the trees are in their prime bearing age of 10 - 20 years. 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 4,900 kcal 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 *Z. spina-christi* seeds 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). This is termed seed dormancy.

Seed dormancy is regarded as the failure of an intact viable seeds to complete germination under favourable condition (Ajiboye, 2010). The dormancy of the *Z. mauritiana* seeds poses a serious problem to its domestication rate. There is dearth of quantified information on the potential of hydro and halo-priming in improving the mean germination time and germination percentage of seeds of forest tree species (Adelani, 2015b). In light of this, this research investigates the germination potentials of *Z. mauritiana* seeds 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 zone of Nigeria between latitude 10^{o} 35^{1} and 10^{o} 34^{1} and longitude 7^{o} 21^{1} and 7^{o} 20^{1} (Adelani, 2015a). Rainfall is approximately 1000m 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).

Experimental Procedure

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 sand from 2mm sieve was collected from the college dam and sterilized at 160^{o}C for 24 hours. The viability of the randomly selected seed samples was assessed by cutting method (Schmidt, 2000). The polypots of $20x5x5cm^{3}$ were filled with sterilized sand in the nursery (Adelani *et al.,* 2014).

Experiment 1: **Effect of hydro-priming on germination of *Z. mauritiana* seeds**.

The effect of hydro-priming on germination of *Z. mauritiana* seeds was assessed using a completely randomized design with four (4) replications. 1000 seeds of *Z. maurtiana* were extracted from the fruits. The seeds were washed and air dried. The initial moisture content of the samples of the seeds was determined by weighing the seeds on Mettler Top Loading Weighing Balance (Model-Mettler PM 11-K) before and after drying to constant weight. Ten seeds represented a replicate. Forty seeds were soaked in water for 0, 6, 8, 12 and 14 hours. The temperature of the water during priming was 28^{o}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). The seeds were also dried back to the initial moisture content. Treated seeds were planted in 4 cm depth of the sterilized sand and 80 ml of water per seed was applied regularly at two days interval (Adelani and Maisamari, 2016). 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. The initial moisture content of the samples of the seeds was determined by weighing the seeds on Mettler Top Loading Weighing Balance (Model-Mettler PM 11-K) before and after drying to constant weight. Ten seeds represented a replicate. Forty seeds were soaked in concentrations of sodium chloride (0.0, 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). The seeds were also dried back to the initial moisture content. Treated seeds were planted in 4 cm depth of the sterilized sand and 80 ml of water per each seed was applied at two days interval (Adelani and Maisamari, 2016). 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:

$$\text{Germination Percentage} = \frac{\text{Total seed germinated}}{\text{Total seed sown}} \times 100$$

Mean germination time was calculated using the relation

$$MGT = \frac{\Sigma(f_x)}{\Sigma x}$$

Schelin *et al.* (2003)

Where x is the number of newly germinated seed on each day and f is the number of days, after seeds were set to germinate. 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 when no seeds germinated again.

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 hydro-priming on the germination of *Z mauritiana* Seeds

The result of the effect of hydro-priming 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 germination percentage value of 68.75% was recorded in *Z mauritiana* seeds hydro-primed for 6 hours. It can be deduced that hydro-priming of seeds for 6 hours allow imbibitions of moisture and other factors necessary for germination to take place. Appropriate hydro-priming hours vary among plant species. This is in consonance with the report of Caseiro *et al*. (2004) who found out that hydro-priming 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 hydro-priming allowed seeds to imbibe water for a longer time and go 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 80.5 days was recorded for 0, 6, 8, 12 and 14 hours respectively. The least mean germination time of 73.55 days was recorded for *Z. mauritiana* seeds soaked in water for 6 hours.

Table 1: Effect of hydro-priming on the germination of *Z mauritiana* seeds

Hydro-priming (Hours)	MGT (days)	Percentage germination (%)
0	94.5[a]	37.50[b]
6	73.55[b]	68.75[a]
8	79.92[b]	55.00[a]
12	74.15[b]	53.75[a]
14	80.5[a]	50.00[a]
SE±	14.0	13.44

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

Effect of concentrations sodium chloride and treatment times 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 0.5 ppm concentration of sodium chloride. Highest germination percentage value of 44.25% was recorded for seeds soaked in 0.3 and 0.5 ppm concentration of NaCl. It can be inferred that higher concentration of NaCl resulted in highest germination percentage. This is contrary to the report of Mariem, *et al.* (2013) who stated that increasing NaCl level led to the reductions in germination percentage for some cultivars of *Coriandrum sativum*. Mariem *et al.* (2013) attributed reduction in germination as result of increasing concentration to prevention of water uptake created by the salinity condition. This can also be due to the toxic effects of ions of the salt such as K^+ and NO_3^- Similar result was obtained by Khajeh Hosseini *et al*. (2003) 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 findings contrary 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. Highest germination percentage value of 54.38% was recorded for seeds treated for 12hours. It can be inferred that seed germination decrease with increasing hours of halo-priming. Contrary to this report, 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). Khajeh- Hosseini *et al*. (2003) attributed their result to the uptake of Na^+ and Cl^- ions by the seed, which maintaining a water potential gradient and allowing water uptake during seed germination. Their results are in agreement with those of Murillo – Amador *et al.* (2002) in cowpea.

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. The percentage germination ranged between 13.75% - 81.28% for seeds treated in 0.2 and 0.5 ppm concentration. Germination percentage value of 81.28% recorded for seeds treated in 0.5 ppm for 12 hours was significantly ($P<0.05$) higher than that of 72 hours (25%), 24 hours (42.50%) and 36 hours (42.50%). Highest value of 81.28% was recorded for *Z. mauritiana* seeds treated in 0.5 ppm concentration of NaCl

for 12 hours. This shows that *Z. mauritiana* seeds responded positively to higher concentration of NaCl and lower period of treatment. This is in consonance with reports of Fredj *et al.* (2013) who stated that the best germination percentage of Coriander (*Coriandrum sativum*) was obtained by soaking seeds in NaCl.

Table 2: Effect of concentrations of sodium chlorine and treatment times on the germination of *Z. mauritiana* seeds

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

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

Table 3: Interactive effect of concentrations of NaCl and treatment times on the germination of the *Z. mauritiana* seeds

NaCl Conc.(ppm)	Treatment times (hours)				
	0	12	24	36	72
0.2	13.75^{c}	68.75^{a}	36.25^{b}	36.25^{b}	20.00^{c}
0.3	17.50^{c}	40.00^{b}	78.75^{a}	43.75^{b}	41.25^{b}
0.4	27.50^{b}	27.50^{b}	35.00^{b}	37.50^{b}	75.00^{a}
0.5	30.00^{c}	81.28^{a}	42.50^{b}	42.50^{b}	25.00^{c}

*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

The result of interactive effect mean germination time of concentrations and treatment times of NaCl on the germination of *Z. mauritiana* seeds is presented in Table 4. The mean germination time ranged between 15.17-28.42days for control in 0.3 and 0.4 ppm concentration. Least mean germination time of 15.17days was recorded for *Z. mauritiana* seeds soaked in 0.3ppm for 0 hour. It can be deduced that untreated seeds germinated faster than treated ones. This is contrary to the report of Abbasdokht *et al.* (2014) who stated that halo-primed seeds had higher Germination Index as compared with untreated seeds due to NaCl and PEG conditions. Similar observation has been reported by Takhti and Shekafandeh (2012) who 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

NaCl Conc. (ppm)	Treatment times (hours)				
	0	12	24	36	72
0.2	24.21[a]	21.73[a]	24.35[a]	20.75[a]	18.9[a]
0.3	15.17[b]	23.92[a]	25.77[a]	23.73[a]	25.23[a]
0.4	28.42[a]	24.11[a]	25.02[a]	18.56[b]	21.85a
0.5	24.31[a]	20.78[a]	22.16[a]	17.14[b]	20.94a
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 germination percentage value of 68.75% was recorded in *Z. mauritriana* seeds hydroprimed for 6 hours. Least mean germination time of 15.17days was recorded for *Z. mauritiana* seeds soaked in 0.3ppm for 0hour (control). For maximum germination percentage value (81.28%) to be obtained for agro-forestry programmes, *Z. mauritiana* seeds need to be treated in 0.5ppm of NaCl for 12hours.

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