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Seed Priming for Improved Seedling Emergence and Vigour of Cordia (*Cordia millennii*) Seed

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ABSTRACT

Effect of seed priming treatments on seedling emergence and vigour traits of *Cordia millennii* seeds were investigated. Sun dried seeds of this tree plant were treated with different seed priming treatments (solutions of sodium chloride, potassium chloride, potassium nitrate and water for 2, 3, and 4 days and hot water temperature at 50, 60 and 70°C for 5, 10 and 15 min soaking time). Seed emergence and vigour traits were assessed and data collected were subjected to analysis of variance and significance of treatment means was determined. From the results, water primed seeds had the highest seedling emergence of 18.3% compared to others including the control treatments. Water treatment for 2 days had the highest seedling length and seedling vigour index while there was significant decrease in seedling length with other treatment solutions including the control. Water solution for 2 days had the highest days to emergence compared to other treatments including the control which recorded the lowest days to emergence index (14 days). Water temperature treatment at 70°C for 5 min soaking recorded the highest seedling emergence; emergence index and seedling length while other treatments had similar effect. Also, water temperature treatment at 60°C for 5 min had greater rate of emergence and seedling vigour index. In conclusion, the normal water temperature priming to improve seedling emergence and vigour of *C. millennii* is 60 or 70°C with 5 min soaking duration. Further studies, which will enhance higher seedling emergence of *C. millennii* above the present level of 40% are hereby advocated.

Key words: Germination, seed quality, seed improvement, treatment, regeneration

INTRODUCTION

Seed quality is defined as a standard of excellence in certain characters that will determine the performance of the seed when sown or stored (Hampton, 2002). Seed quality encompasses all those attributes, which contribute to seed performance including genetic purity, physical purity, germination and vigour (Adeshile, 2010). Seed quality relates to the characteristics of seed, which result in the high field performance and eventually high seed/grain yield (Adebisi, 2004). Studies have shown that seed quality can be largely influenced by the environmental factors during seed production, harvesting, processing, storage and treatments such as seed priming (Adebisi *et al.*, 2008).

Seed priming is a technique of hydration and drying that result in more rapid germination when the seed are re-imbibed. It is a low cost, low-risk technique that is easily adopted by resource-poor farmers in developing countries and increases the yield of tropical crops. It is a simple technology that farmers can use to improve crop establishment and increase yield (Harris *et al*., 2001; Harris and Mottram, 2004).

Cordia millennii is an indigenous tree species, which belong to the family Boraginanceace. It can be found in the lowland rainforest zone of Nigeria. It is a common shade tree in towns and villages in Western Nigeria, seldom reaching more than 40 ft in height. It occurs naturally in areas receiving varying amounts of annual rainfall (Nwoboshi, 2000).

Cordia millennii is one of the Nigerian indigenous timber tree species. The specie population is fast diminishing in the natural forest due to its economic importance and excessive exploitation. In Nigeria, there is no known man made (artificial) plantation of the species. Furthermore, the rate of natural regeneration in the natural forest particularly under mother trees is too low (Nwoboshi, 2000).

There is no evidence to show any previous study regarding the raising of the species for afforestation and regeneration project. This may probably be due to the hard seed coat and the presence of natural inhibitor that prevent germination from taking place. Apart from this, the activities of illegal poacher and encroachers have caused an extinction of the species in our various forest estates. In view of the above, there is need to investigate the efficacy of various treatments in improving seed emergence and seedling vigour traits of the seeds, so that people living in both rural and urban areas will be able to grow the tree and thereby prevent an extinction in our forest estate. The ultimate economic result of its promotion will positively affect our natural life. Therefore, objective of this study was to evaluate the efficacy of different salt solutions, hot water treatment and soaking duration for the improvement of emergence and seedling vigour of *Cordia* seed.

MATERIALS AND METHODS

Seed materials: The experiment was carried out at Forestry Research Institute of Nigeria (FRIN) nursery site at Ore, Ondo State, South West, Nigeria. The fruits of *C. millennii* were collected from Oluwa Forest Reserve, Ondo State in October 2007 and seeds were extracted from the fruits on the same day and sun dried for two days, thereafter the seeds were prepared for various treatments.

Seed priming: In the first experiment, four seed priming solutions were utilized (calcium chloride, sodium chloride, potassium nitrate and water solutions) for the study. One hundred seeds were soaked in each of three different salt solutions and water for two, three and four days. In the second experiment, hot water treatment was used. Hundred seeds were soaked in hot water with different temperature regimes of 50, 60 and 70°C for 5, 10 and 15 min. Control (ordinary water) treatment was included in each of the treatment. Each experiment was carried out twice (October-November, 2007 and repeated in January-February, 2008). Each experiment was conducted in a completely randomized design with three replications.

Seed quality assessment: Primed seeds from the two experiments were assessed for the following seed quality traits.

Seedling emergence capacity: This was assessed two days after the commencement of seed emergence.

Seedling length: This was assessed at the end of 30 days at the commencement of seed emergence by measuring the length in centimetres (cm) from the tip of the cotyledon to the point of radical emergence.

Rate of emergence: This was calculated as:

$$\left\{\frac{\text{No. of seed germinated at 10 days}}{\text{No. of seed sown}}\right\}\times 100$$

Seedling Vigour Index (SVI): This was determined by multiplying percentage seed emergence by the average of seedling length after 30 days of emergence (Lee *et al*., 1998) and divided by 100 (Adebisi, 2004).

Emergence index: This was calculated as:

$$\Sigma GT/Tt$$

where, Gt is the number of seed emerged on day t and Tt is the number of days.

The seedlings were constantly and evenly watered to avoid dryness and weeding operation was carried out as at when necessary. Shading was provided to avoid direct ray of sunlight.

Data analysis: The experiment was carried out in a completely randomized design with factorial arrangement of treatments. Data collected were analysed using Analysis of Variance (ANOVA) and significant of treatment means was determined using Duncan Multiple Range Test (DMRT) at 5% level of probability. All analyses were carried out using SPSS version 16 statistical software package.

RESULTS

Table 1 shows the result of analysis of variance for seed quality traits evaluated after seed priming treatments in two screen house trials of *C. millennii* seeds. Trial effect, interaction effect of trial and salt as well as trial and treatment duration were not significant on all the seed quality traits examined. There was significant effect of salt treatment and treatment duration on seedling emergence capacity, rate of emergence, seedling vigour index and seedling length. The interaction effects of treatment and treatment duration of priming were however, found to be significant on seedling emergence capacity, seedling vigour index and seedling length. The three-way interaction effect of trial, salt and duration was not also significant on all seed quality characters.

In Table 2, there were significant differences among the four salts solutions evaluated for all seed quality traits tested. Water solution treatment had the highest seedling emergence of 18.3% compared to others, which had almost similar effect whereas seed primed with CaCl and water had the highest rate of emergence index of 15.62 and 15.75 days, respectively compared to others, which had similar effect. Regarding seedling length, water solution priming had the highest seedling length of 13.16 cm followed by KNO_3 (10.48 cm) while seed treated with NaCl and $CaCl_2$ had similar effect. Seeds primed with water solution gave the highest seedling vigour index (3.38) followed by KNO_3 (1.69) while NaCl treatment recorded the least (1.47). In terms of priming

Table 1: Result of analysis of variance (ANOVA) for seed quality traits evaluated after priming with four salt solutions in two screen house trials of *Cordia millennii* seeds

Source of variation	df	Seed emergence capacity (%)	Emergence index (days)	Speed of emergence (%)	Seedling length (cm)	Seedling vigour index
Replication	2	97.476**	10.97^{ns}	792.26^{ns}	1.012^{ns}	0.048^{ns}
Trial (T)	1	0.502^{ns}	0.041^{ns}	1.04^{ns}	0.621^{ns}	0.062^{ns}
Salt (S)	3	44.225**	34.57*	2010.15**	146.578**	19.316*
Duration (D)	3	312.225**	28.37*	889.82*	710.594**	56.160*
T×S	3	0.330^{ns}	3.12^{ns}	1.04^{ns}	0.516^{ns}	0.170^{ns}
T×D	3	0.487^{ns}	2.93^{ns}	0.59^{ns}	0.762^{ns}	0.459^{ns}
S×D	9	236.742**	26.31^{ns}	880.15**	337.655**	42.577**
T×S×D	9	0.610^{ns}	1.49^{ns}	0.59^{ns}	0.440^{ns}	0.129^{ns}
Error	62	8.638	14.668	284.56	1.099	0.036

**, *Significant at 1 and 5% level of probability, respectively, ns-:Not significant

Table 2: Main effect of salt solution and duration on seedling emergence capacity and seedling vigour traits in *Cordia millennii*

Treatment	Seedling emergence capacity (%)	Emergence index (days)	Rate of emergence (%)	Seedling length (cm)	Seedling vigour index
Salt solutiou					
NaCl	16.65^{ab}	13.29^{b}	55.75^{a}	7.84^{c}	1.47^{c}
$CaCl_2$	16.63^{ab}	15.62^{a}	37.66^{b}	8.13^{c}	1.62^{bc}
KNO_3	14.98^{b}	14.08^{b}	39.08^{b}	10.48^{b}	1.69^{b}
Water	18.30^{a}	15.75^{a}	36.08^{b}	13.16^{a}	3.38^{a}
Mean	16.64	14.68	42.14	9.90	2.04
Soaking duratiou					
2 days	21.65^{a}	16.29^{a}	37.08^{b}	15.04^{a}	4.00^{a}
3 days	14.98^{bc}	14.29^{a}	47.50^{a}	11.47^{b}	1.71^{c}
4 days	16.63^{b}	14.29^{a}	47.33^{a}	10.89^{b}	2.14^{b}
Control	13.30^{c}	13.80^{b}	36.67^{b}	2.22^{c}	0.29^{e}
Mean	16.64	14.67	42.14	9.90	2.04

Means followed by the saine letters along the column are significantly different at p = 0.05 according to Duncan's multiple range test

duration, there were significant differences among the four salt priming durations for all the seed quality traits tested. Priming for two days gave the highest seedling emergence (21.65%), seedling length (15.04 cm) and seedling vigour index (4.00) compared to other priming durations. Two-four days priming duration recorded the highest number of days to emergence (emergence index) compared to control priming. The highest rate of emergence values of 47.33 to 47.50 were obtained with seed primed for three and four days compared to other priming duration treatments.

From the result presented in Table 3 there were significant differences among four salt solutions at each of priming duration (two, three and four days) examined for seed emergence capacity, rate of emergence, seedling length and seedling vigour index. Priming with water solution for two days had the highest seed emergence capacity of 33% followed by NaCl (20%) and KNO_3 (20%). With priming duration of three days, NaCl had the highest emergence capacity (20%) compared to others, which had similar effects whereas at four days duration, $CaCl_2$ recorded the highest seedling emergence capacity of 27% above other salt solutions. For rate of emergence, priming with NaCl for two days recorded the highest rate of emergence (44%), compared to other salt solutions, which recorded similar effect. At three days priming duration, NaCl gave the highest

Table 3: Effect of priming with salt solution and soaking duration on seedling emergence and vigour traits in *Cordia millenii* seed

	Duration of soaking		
Treatment	2 days	3 days	4 days
Emergence capacity			
Sodium chloride	20^{ab}	20^{a}	13^{b}
Calcium chloride	13^{c}	13^{b}	27^{a}
Potassium nitrate	20^{ab}	13^{b}	13^{b}
Water	33^{a}	13^{b}	13^{b}
Control	13^{c}	13^{b}	13^{b}
Mean	19.8	14.4	15.8
Emergence index			
Sodium chloride	14^{c}	14^{b}	13^{c}
Calcium chloride	16^{b}	14^{b}	18^{a}
Potassium nitrate	17^{b}	11^{c}	14^{b}
Water	19^{b}	18^{a}	12^{c}
Control	14^{c}	14^{b}	14^{c}
Mean	16	14.2	14.2
Speed of emergence			
Sodium chloride	44^{a}	67^{a}	75^{a}
Calcium chloride	37^{c}	50^{b}	28^{d}
Potassium nitrate	33^{c}	50^{b}	37^{c}
Water	34^{c}	33^{c}	50^{b}
Control	37^{c}	37^{c}	37^{c}
Mean	37	47.4	45.4
Seedling length			
Sodium chloride	12.7^{b}	10.9^{c}	5.6^{b}
Calcium chloride	4.9^{d}	8.8^{d}	16.6^{a}
Potassium nitrate	10^{c}	13.4^{a}	16.3^{a}
Water	32.6^{a}	12.8^{b}	5.5^{b}
Control	2.2^{e}	2.2^{e}	2.2^{c}
Mean	12.48	9.62	9.24
Seedling vigour index			
Sodium chloride	2.5^{b}	10.89^{a}	0.9^{c}
Calcium chloride	0.7^{d}	1.7^{b}	4.3^{a}
Potassium nitrate	1.9^{c}	1.8^{b}	2.8^{b}
Water	10.9^{a}	1.7^{b}	0.7^{c}
Control	0.29^{e}	0.29^{e}	0.29^{e}
Mean	3.26	3.28	1.79

Means followed by the same letters along the column are not significantly different according to Duncan's multiple range test at 5% level of probability

rate of emergence (67%), followed by $CaCl_2$ (50%) and KNO_3 (50%), while water and control treatments recorded the least rate of emergence value. Priming for four days duration with NaCl gave the highest rate of emergence of 75% followed by water while $CaCl_2$ gave the lowest (28%).

Still in Table 3 priming with water for two days had the highest seedling length of 32.60 cm while $CaCl_2$ recorded the lowest seedling length of 4.9 cm. Seeds primed with KNO_3 solution for three days had the highest seedling length (13.40 cm), followed by water solution (12.80 cm). There was significant increase in seedling length of seeds primed with $CaCl_2$ and KNO_3 for four days over other treatments while NaCl and water treatments had similar effect. There was no significant

difference in seedling vigour index of tested seeds at 0 day priming. Priming with water solution for two days gave the highest seedling vigour index of 10.89 compared to other treatments. With priming duration of three days, seeds primed with NaCl recorded the highest seedling vigour index of 10.89 compared to other salt treatments. At four days priming, $CaCl_2$ had the highest seedling vigour index of 4.3, followed by KNO_3 (2.8) while NaCl and water treatments had similar effect.

Table 4 shows the result of Analysis of Variance (ANOVA) for seedling emergence capacity and seedling vigour traits after hot water treatments. The trial effect was not significant on all the seed quality traits examined. The effects of hot water temperature and soaking time were highly significant on all the traits except effect of soaking time which was not significant on emergence index. The interaction effects of water temperature and soaking time were highly significant on all the traits except seedling vigour index. The effect of trial×soaking time was significant on seedling vigour index only.

From the data presented in Table 5, the result showed that were significant differences among the four water temperatures tested for seedling emergence capacity, rate of emergence, seedling length and seedling vigour. Water temperature at 60°C had the highest seedling emergence of 28% followed by 50 and 70°C treatment above the control. As regards seedling length, water

Table 4: Result of analysis of variance (ANOVA) for seedling emergence capacity and vigour traits after hot water treatment in *Cordia millennii* seed

Source of variation	df	Seed emergence capacity (%)	Emergence index (days)	Rate of emergence (%)	Seedling length (cm)	Seedling vigour index
Replication	2	16.652^{ns}	11.29^{ns}	378.500^{ns}	0.517^{ns}	0.095^{ns}
Trait (T)	1	0.076	0.050^{ns}	1.125^{ns}	0.0911^{ns}	0.017^{ns}
Temp. (W)	3	661.161**	217.71**	259.940**	3146.295**	539.599**
Soaking time (S)	2	79.831**	27.17^{ns}	1623.275**	864.298**	947.779**
T×W	3	0.0158^{ns}	5.55^{ns}	1.125^{ns}	0.002^{ns}	0.009^{ns}
T×S	2	0.0170^{ns}	5.55^{ns}	1.125^{ns}	0.001^{ns}	416.375**
W×S	6	619.730**	58.65**	795.634*	952.316**	0.003^{ns}
T×W×S	6	0.0109^{ns}	5.55^{ns}	1.125^{ns}	0.003^{ns}	0.043^{ns}
Error	46	4.481	11.683	305.63	0.236	0.0451

**, *Significant at 0.01 and 0.05 level of probability, respectively, ns: Not significant, Temp: Temperature

Table 5: Effect of hot water temperature and soaking time on seedling emergence capacity and seedling vigour traits in *Cordia millennii* seed

Treatment	Seedling emergence capacity (%)	Emergence index (days)	Rate of emergence	Seedling length (cm)	Seedling vigour index
Water temp. (°C)					
0	5^{c}	11.00^{b}	50.0^{a}	2.20^{c}	0.29^{c}
50	25^{b}	12.78^{b}	46.67^{a}	26.12^{b}	6.39^{b}
60	28^{a}	17.67^{a}	47.22^{a}	26.89^{b}	13.00a
70	23^{b}	17.89^{a}	40.99^{a}	33.00^{a}	10.06a
Mean	20.2	11.87	46.22	22.05	7.43
Soaking duration					
5 minutes	21^{a}	13.90^{a}	55.58^{a}	27.17^{a}	14.68^{a}
10 min	18^{b}	16.00^{a}	40.21^{b}	20.00^{b}	4.15^{b}
15 min	18^{b}	14.58^{a}	42.83^{b}	15.25^{b}	3.47^{b}
Mean	19	14.83	46.21	20.81	7.43

Means followed by the same letter along the column are not significantly different according to Duncan's multiple range test at 5% level of probability

temperature at 70°C had the highest seedling of 33 cm followed by water temperature treatment at 50 and 60°C treatment while 0°C treatment recorded the least seedling length of 2.20 cm. The main effect of hot water treatment was highly significant on seedling vigour index seedling with 60 and 70°C recording the greater vigour index levels of 13 and 10.06, respectively while temperature at 0°C recorded the least seedling vigour level of 0.29.

On the soaking duration effect, there were significant differences among the soaking duration time for the seed quality examined. Soaking duration for 5 min irrespective of temperature treatment recorded the highest seedling emergence (21%), rate of emergence (55.58%), seedling length (27.17 cm) and seedling vigour index (14.68) compared to other soaking duration treatments, which had similar effect.

Data on the effect of hot water treatment and soaking duration on seedling vigour index and seedling length of *C. millennii* seeds are shown in Table 6. Significant differences were observed among the four hot water treatments at five, 10 and 15 min of soaking for seedling vigour and seedling length. Seeds of *Cordia* primed with hot water at 60°C for 5 min gave significant greater seedling vigour level (30.06) above other treatments while similar trend was obtained at 15 min soaking duration along with 5°C hot water treatment. Priming with hot water treatment had higher vigour level at each priming duration compared to control treatment. For seedling length, seeds primed for 5 and 10 min at 70°C water treatment gave the highest seedling length of 58.67 and 30.56%, respectively above other treatments. Water treatment at 60°C for 15 min resulted in higher seedling length (24.53 cm) above other treatments including control.

Table 7 shows the effect of hot water treatment and soaking duration on seed emergence capacity, emergence index and speed of emergence of *C. millennii* seeds. Seeds primed with hot water at 70°C for five minutes had the highest emergence capacity of 40% compared to other treatments, followed by 60 and 50°C water treatments. After 10 and 15 min soaking duration in 60 and 50°C water temperature, *C. millennii* seeds recorded highest emergence capacity of 27-28% above other treatments. All the treatments gave higher emergence capacity above the control treatment. For the emergence index, hot water at 70°C had the longer period of emergence at five minutes, compared to other treatments, which had statistical lower days to emergence of 11-13 days. However, at 10 min soaking duration, hot water at 60°C had the highest emergence

Table 6: Effect of hot water treatment and soaking duration on seedling vigour index and seedling length of *Cordia millennii* seed

		Soaking duration (min)		
Seed quality trait	Water temp. treatments (°C)	5	10	15
Seedling vigour index	0	0.30^{d}	0.32^{b}	0.26^{b}
	50	4.94^{c}	7.72^{a}	6.52^{a}
	60	30.06^{a}	7.41^{a}	6.53^{a}
	70	23.42^{b}	6.17^{a}	0.58^{b}
	Mean	14.68	5.40	3.47
Seedling length	0	2.22^{c}	2.19^{c}	2.18^{c}
	50	24.73^{b}	29.12^{ab}	2.18^{c}
	60	23.01^{b}	28.00^{b}	24.53^{a}
	70	58.67^{a}	30.56^{a}	9.78^{b}
	Mean	27.15	22.46	9.67

Means followed by the same letter along the column are not significantly different according to Duncan's multiple range test at 5% level of probability. Temp: Temperature

Table 7: Effect of hot water treatment and soaking duration on seedling emergence capacity, emergence index and rate of emergence of *Cordia millennii* seed

		Soaking duration (min)		
Seed quality trait	Water temp. treatments (°C)	5	10	15
Seed emergence capacity (%)	0	11^{c}	11^{c}	11^{c}
	50	20^{b}	27^{a}	27^{a}
	60	23^{b}	28^{a}	27^{a}
	70	40^{a}	20^{b}	9^{c}
	Mean	23.5	21.5	18.5
Emergence index(days)	0	11^{b}	11^{b}	11^{b}
	50	14^{b}	12^{b}	13^{a}
	60	12^{b}	23.3^{a}	18^{a}
	70	19^{a}	18^{b}	17^{a}
	Mean	14	16.07	14.75
Rate of emergence (%)	0	50^{c}	50^{a}	50^{a}
	50	67^{a}	37^{b}	36^{b}
	60	58^{b}	53^{a}	58^{a}
	70	56^{b}	40^{b}	27^{c}
	Mean	57.75	45	42.75

Means followed by the same letters along the column are not significantly different according to Duncan's multiple range test at 5% level of probability

index of 23.3 days while other treatment had similar lower days to emergence while seeds primed with hot water of 50-70°C had higher days to emergence (13-18 days) compared to control with 11 days. With rate of emergence, seed primed with hot water at 50°C for five minutes had the highest rate of emergence of 67%, followed by temperature at 60 and 70°C treatments which recorded rate of emergence of 58 and 56%, respectively compared to control (50%). Similarly, seed primed for 10 and 15 min at 60°C gave significant highest rate of emergence compared to other treatments including control.

DISCUSSION

The study revealed that seed priming (using three salt solutions) and duration effect were highly significant on emergence capacity, rate of emergence and seedling length and seedling vigour of *Cordia* seeds. This indicates that differences existed among the three salts solution on these four seed quality traits due to differences in chemical composition of the salts (KNO_3, NaCl and $CaCl_2$) as well as time of soaking. Hence, efficacy of these salts on seedling emergence and seedling vigour traits dependent on the priming duration. Investigation of Alderete-Chavez *et al.* (2011) on effect of seed priming with acid solution in *Bauhinia divaricata* seeds showed that seeds treated with sulphuric acid responded positively in all cases while the immersion in the acid for 15 or 20 min were the treatment that showed the best result for promotion of germination compared to the control. Ajala *et al.* (2008) reported significant differences in seed quality of West African rice due to differences in salt solution of KNO_3, $CaCl_2$ and NaCl.

Farooq and Basra (2008) also reported significant effect of salt solution treatment on emergence and stand establishment. Giri and Schillinger (2003) observed that none of the priming media benefited field emergence in all cultivars of wheat tested compared with checks.

The study also revealed that water solution had the highest seedling emergence capacity of 33% after soaking for two days compared to other salt solution including the control. Similarly, seed primed with water solution for two days had the highest seedling vigour index (10.9),

seedling length (32.0 cm) and emergence index (18.5 days) when compared to other salt solution treatments. This shows that priming in water for two days is sufficient to soften the seed coat and subsequently triggered up germination process. Berchie *et al.* (2010) observed that seed priming significantly affected the final percentage of seedling establishment of bambarra groundnut while seedling emergence was delayed under the control treatment.

Water temperature treatment gave 50% improvement in *Cordia* emergence than control treatment while seeds soaked in water temperature of 50°C gave 18% higher emergence above control. Among the chemical salt solutions, KNO_3 and $NaCl_2$ recorded significant higher seedling emergence capacity after 2 days soaking and this was still maintained by NaCl only after 3 days soaking. On emergence index, KNO_3 treated seeds for four days had lower days to emergence. With rate of emergence, priming with $CaCl_2$ for two, three and four days soaking recorded superior rate of emergence while $CaCl_2$ treatment after four days soaking was found with highest seedling vigour. Similar observations were reported by Ajala *et al.* (2008) in West African rice seed quality after treatment with the same chemical salt solution.

In the study of Rajpar *et al.* (2006), seed priming had no significant effect on the straw dry weight and ion contents of wheat determined in grains. However, seedlings were significantly faster in emergence, took fewer days to mature and gave significantly higher grain yield per hectare. Rha and Jamil (2007) observed that priming with GA_3 increased the final germination percentage and germination rate of sugar beet under saline condition and thus was also supported by the findings of Farooq *et al.* (2005) The study also showed the effects of hot water treatment and duration of soaking was highly significant on seed emergence capacity, seedling length and seedling vigour index and seedling vigour. This indicates that there is an opportunity to select for treatment with higher efficacy on seed quality of *Cordia* tree. Similar finding on hot water treatment were reported by Emongor *et al.* (2004) on *Corchorus tridens* seeds. Kaur *et al.* (2009) observed maximum shoot length of seedling when seeds of *Chlorophytum borivilianum* were treated with 10^{-6} concentration of testosterone, cholesterol and 24-epibrassinolide compared to the control. The study further demonstrated that hot water treatment at 70°C for five minutes had the highest seedling emergence of 40% compared to other treatments including control, which recorded the lowest seedling emergence of 11%. However, hot water at 50°C and soaking duration of 5 min was found with 66.7% rate of emergence compared to other treatment including the control. Soaking of seeds for 15 min at 60°C temperature enhanced higher rate of emergence above other treatment as well as control. With seedling vigour, all the hot water treatment durations enhanced seedling vigour above control treatment with highest seedling vigour of 30.06 recorded at 60°C for 5 min soaking. For seedling length, all hot water treatment irrespective of soaking duration, recorded higher seedling length above control treatment at 70°C and soaking for five minutes gave the highest of 58.67 cm compared to other treatments. This may be due to the fact that temperature at this period (70°C for 5 min) had no deleterious effect on embryo and the cotyledon, which provides early nutrient for the emergence of growth and development of the seedlings.

CONCLUSION

It can therefore, be concluded that there were significant differences in the seed quality traits studied after salt solution and hot water treatments. The higher increment in rate of emergence, seedling emergence, seedling vigour index and emergence index showed clearly that water solution for two days had power to break the hard seed coat of *C. millennii* and enhancing seedling vigour.

Hot water treatment at 70°C and 5 min soaking duration will break the dormancy and ensure rapid seed emergence and seedling vigour in *Cordia* tree. It is however, not advisable to raise *C. millennii* seeds without being treated because of the hard seeds coats and presence of inhibitors, which militate against the normal growth and development of the seedlings.

Cordia millennii is one of those tree species that is being neglected in which its uses and modes of propagation are not being researched upon adequately. Increase in temperature treatments above 70°C with varying different soaking durations is hereby recommended for investigation. Finally, because of diverse *C. millennii* uses and economic importance, more research should be encouraged in order to utilize this tree species to the fullest of all its benefits, which will invariably benefit mankind.

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REFERENCES

Adebisi, M.A., 2004. Variation, stability and correlation studies in seed quality and yield components of sesame (*Sesamum indicum* L.). Ph.D. Thesis, University of Agriculture, Abeokuta, Nigeria.

Adebisi, M.A., J.A. Ola, D.C.A. Akintobi and I.O. Daniel, 2008. Storage of life of sesame (*Sesamum indicum* L.) seed under humid tropical conditions. Seed Sci. Technol., 36: 379-387.

Adeshile, A.A., 2010. Optimization of seed priming treatment to increase seed germination, emergence and seedling growth of NERICA rice (*Oryza sativa* L.). Project Report. Department of Plant Breeding and Seed Technology, University of Agriculture, Abeokuta, Nigeria, pp: 42.

Ajala, M.O., M.A. Adebisi, O.O. Ajani and T.O. Adekola, 2008. Seed invigoration by priming in NERICA rice (*Oryza sativa* L.). Proceedings of the 42nd Annual Conference of Agricultural Society of Nigeria, Oct. 19-23, Ebonyi State University, Abakaliki, Nigeria, pp: 124-129.

Alderete-Chavez, A., N. De la Cruz-Landero, J.J. Guerra-Santos, E. Guevara and R. Gelabert *et al*., 2011. Promotion of germination of *Bauhinia divaricata* L. seeds by effects of chemical scarification. Res. J. Seed Sci., 4: 51-57.

Berchie, J.N., H. Adu-Dapaah, J. Sarkodie-Addo, E. Asare, A. Agyemang, S. Addy and J. Donkoh, 2010. Effect of seed priming on seedling emergence and establishment of four bambarra groundnut (*Vigna unguiculata* L. Verdc) Landraces. J. Agron., 9: 180-183.

Emongor, V.E., T. Mathowa and S. Kabelo, 2004. The effect of hot water treatment, sulphuric acid, nitric acid, gibberellic acid and ethephon on the germination of corchorus (*Corchorus tridens*) seed. J. Agron., 3: 196-200.

Farooq, M., S.M.A. Basra, B.A. Saleem, M. Nafees and S.A. Chisti, 2005. Enhancement of tomato seed germination and seedling vigour by osmopriming. Pak. J. Agric. Sci., 42: 36-41.

Farooq, M. and S.M.A. Basra, 2008. Rice cultivation by seed priming. Seed Sci. Technol., 33: 612-620.

Giri, G.S. and W.F. Schillinger, 2003. Seed priming winter wheat for germination, emergence and yield. Crop Sci., 43: 2135-2141.

Hampton, J.G., 2002. What is seed quality. Seed Sci. Technol., 30: 1-10.

Harris, D. and A. Mottram, 2004. On farm seed priming reduces risk and increases yield in tropical crops. Centre for Arid Zona Studies, University of Wales, Bangor Cinoynedd, LL 572 UW United Kingdom.

Harris, D., B.S. Raghubanshi, J.S. Gangwar, S.C. Singh, K.D. Joshi, A. Rashid and P.A. Hollington, 2001. Participatory evaluation by farmers of on farm seed priming in wheat in India, Nepal and Pakistan. Exp. Agric., 37: 403-415.

Kaur, R., S. Arora and A.K. Thukral, 2009. Enhancing seed germination of *Chlorophytum borivilianum* Sant. Et Fernard, with PGRs. Steroidal Hormones Zinc. Res. J. Seed Sci., 2: 32-39.

Lee, S.S., J.H. Kim, S.B. Hong, H. Vun and E.H. Park, 1998. Priming effects of Rice on seedling establishment under adverse soil condition. Korean J. Crop Sci., 43: 194-198.

Nwoboshi, C.L.N., 2000. Principle of Tropical Silviculture. 2nd Edn., University Press, University of Ibadan, Nigeria, pp: 18.

Rajpar, I., Y.M. Kharif and A.A. Memon, 2006. Effect of seed priming on growth and yield of wheat (*Triticum aestivum*) under non-saline conditions. Int. J. Agric. Res., 1: 259-264.

Rha, E.S. and M. Jamil, 2007. Gibberrelic acid enhance seed water uptake, germination and early seedling growth in sugar beet under water stress. Pak. J. Bio. Sci., 10: 654-658.