



THE EFFECTS OF SEED PRIMING TECHNIQUES IN IMPROVING
GERMINATION AND EARLY SEEDLING GROWTH OF WATER MELON –
Citrullus lanatus THUMB



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Abstract: The effect of seed priming techniques in improving germination and early seedling growth of *Citrullus lanatus* Thumb (Water melon) was carried out in Odi, Bayelsa State, Nigeria. This experiment was conducted in a completely randomized design with three replications. The factors examined include four treatment groups of seed priming and control (without priming). The treatment groups include water, Sodium chloride (with concentration of 5 g/l), Ethylenediaminetetraacetic acid (with concentration of 5 g/l) and 1-Naphthaleneacetic acid (with concentration of 1 mg/L) for 12 h, respectively. In this experiment traits such as germination percentage, germination rate, radicle length and plumule length were measured. Data were analyzed by using SPSS (version 20.0) software and the differences between means were compared by Turkey's HSD post-hoc analysis ($P < 0.05$). Comparison of seed germination characteristics and seedling vigor of the four different treatment groups showed that seeds primed by water had the highest percentage and rate of germination with 96% and 1.71, plumule length (36.57 ± 9.52) and dry weight of seedling (0.603 g) of watermelon (*Citrullus lanatus*) except for the radicle length which NAA had the highest but there was no significant difference ($p < 0.05$) among the treatment. In conclusion, primed seeds with water improved *Citrullus lanatus* germination potential and seedlings growth.

Keywords: Water melon, germination percentage, plumule, potential, priming

Introduction

Seed priming is a pre-sowing treatment which improves seed performance under environmental conditions (Ashraf and Foolad, 2005). Priming allows some of the metabolic processes necessary for germination to occur without germination taking place. This technique has become a common seed treatment that can increase germination rate, percentage and uniformity of germination or seedling emergence, and to increase seed tolerance, mainly under unfavorable environmental conditions (Basra *et al.*, 2005; 2006; Farooq *et al.*, 2006, 2007). Over the past two decades, seed enhancement through seed priming has led to great improvements in a grower's ability to routinely achieve this goal in both the field and greenhouse. Numerous vegetable and ornamental crop species have been primed successfully. Rapid seed germination and stand establishment are critical factors for crop production under stress conditions. In many crop species, seed germination and early seedling growth are the most sensitive stages to stresses. Constraints to good cost abolishment include improper seedbed preparation (Joshi, 1987), low quality seed, untimely sowing, poor sowing techniques (Bradford, 1986), inadequate soil moisture (Harris *et al.*, 1999) and adverse soil conditions (Lee *et al.*, 1998). The most important priming treatments are halopriming and hydro priming. More so, seeds may be primed with plant growth regulators such as NAA, GA₃, IAA, IBA (Subedi and Ma, 2005). Halopriming is a pre-sowing soaking of seeds in salt solutions, which enhances germination and seedling emergence uniformly under adverse environmental conditions. Hydropriming is a pre-sowing soaking of seeds in water. Technology that progress seed germination and stand establishment would enable the parental plants to capture more soil moisture, nutrients, solar radiation, and help to attain high synchronization of the reproductive stages of each parents and mature before the occurrence of cool stress in fall (Subedi and Ma, 2005). Therefore, seed invigoration treatments have been developed to improve seed performance during germination and seedling early growth. Primed seeds emerged 12 h earlier than non-primed seeds (Dell-Aquila and Tritto, 1990). This may be due to increase in activity of enzymes such as amylase, protease and lipase which have great role in breakdown of macromolecules for growth and

development of embryo that ultimately resulted in early and higher seedling emergence. Besides better establishment, farmers have reported that primed crops grew more vigorously, flowered earlier and yielded higher. Aliabadi *et al.* (2011) showed that the highest seedling vigor, germination percentage and seedling dry weight were achieved by hydro-priming after 12 hours in Basil (*Ocimum basilicum* L). According to Fredj *et al.* (2013), the best germination percentage of coriander (*Coriandrum sativum*) was obtained by soaking seeds in NaCl at 4 g/l for 12 h. Normally priming is done either in low water potential solution (osmopriming) or in tap water (hydro-priming), however, incorporation of plant growth regulators during priming have improved seed germination, establishment and crop performance (Shafiei and Ghobadi, 2012). Demir & Van Venter (1999) showed that osmoconditioning (2% KNO₃, 20°C, 6 d) or hydropriming (30°C, 18 h) increased germination under osmotic stress in watermelon (*Citrullus lanatus* (Thunb.) seeds. Mohammad *et al.* (2010) also showed that 3% KNO₃ had the most effective impact on emergence and seedling growth of watermelon with the germination, germination rate and plumule length increasing by 17.87, 18.65 and 4.68%, respectively compared to other priming media (HCL 0.1N, NaCl 1.5N, PEG 6000 3% and none primed). However, the previous studies indicate that some benefits are associated with pre-sowing treatments for seed vigor enhancement, but there is dearth of information about the germination performance of seeds of *Citrullus lanatus* (Thunb.) primed by distilled water and NaCl, Ethylenediaminetetraacetic acid (EDTA) and 1-Naphthaleneacetic acid (NAA) solutions for 12 h. Therefore, the present study was carried out with the aim of evaluating the effect of seed priming techniques in improving germination and early seedling growth of *C. lanatus* under laboratory conditions.

Materials and Methods

The study was conducted in the seed Research laboratory of Genetic Engineering Bioresources Unit, Bioresources Development Centre, Odi, Bayelsa State, Nigeria. Before the start of experiment, seeds were surface sterilized in 1% sodium hypochlorite solution for 3 min, then rinsed with distilled water and air-dried. Seeds of *Citrullus lanatus* were

subjected to seed priming. Seeds were treated with the following seed-soaking media: (i) unsoaked seed (control); (ii) seeds primed by distilled water; (iii) seeds primed by 5 g/l NaCl (Sodium chloride) (iv) seeds primed by 5 g/l EDTA (v) seeds primed by Plant Growth Regulator i.e. 1 mg/l NAA (1-Naphthaleneacetic acid). The duration of priming treatments was 12 h for each. The seeds were placed in liquid priming media at 25°C. Seeds were covered with plastic bags to refuse moisture loss. After soaking, seeds were washed with distilled water, and then redried in the incubator at 25°C in the dark. Germination test was conducted by placing 25 seeds from each of the treatments in 90 mm diameter Petri dishes on Whatman filter paper that was moistened with 5 ml of respective test solutions and were kept in germinator at 25°C in dark condition. A completely randomized design with three replications was used. Radicle protrusion of 2 mm was scored as germination (Kaya *et al.*, 2006). Germination was counted in 24 hours intervals and continued up to day 14. The seedlings were evaluated as described in Seedling Evaluation Handbook (ISTA, 2008).

Final germination percentage (%), mean germination rate, and seedling dry weight (g) was recorded after 14 days of planting on filter paper while plumule and radicle length (mm) was recorded two days interval. All the data obtained from the experiments were subjected to an analysis of variance (Two way ANOVA) using SPSS (version 20.0) software and the difference between means were compared by Turkey's HSD post-hoc analysis ($P < 0.05$).

Germination percentage (GP) was calculated based on equation (Ashraf and Foolad, 2005):

$$GP = (\text{Total germinated seed}) / (\text{Total number of seed})$$

Then the mean germination rate was calculated according to the following equation (Ellis *et al.*, 1987):

$$MGR = n / Dn$$

Where MGR is the mean germination rate, n is the number of seeds germinated on day and Dn is the number of days from the start of test.

Results and Discussion

Seed germination and seedling growth are critical for seedling at the first life stages and often subject to high mortality rates. The three early phases of germination are: (i) imbibition, (ii) lag phase, and (iii) protrusion of the radical through the testa (Simon, 1984). Priming is a procedure that partially hydrates seed, followed by drying of seed, therefore germination processes begin, but radicle emergence does not occur. There are reports that hydration of seed up to, but not exceeding, the lag phase with priming permits early DNA replication (Bray *et al.*, 1989), increased RNA and protein synthesis (Fu *et al.*, 1988; Ibrahim *et al.*, 1983), greater ATP availability (Mazor *et al.*, 1984), faster embryo growth (Dahal *et al.*, 1990), repair of deteriorated seed parts (Karssen *et al.*, 1989; Saha *et al.*, 1990). These help radicle protrusion through the seed coat and shorten the time to seed germination. It was revealed from this study that different priming techniques can have various effects on germination of *Citrullus lanatus* (water melon) seeds.

Results showed that, for most evaluated germination parameters, seeds primed by water for 12 h were most effective compared to other treatments (NaCl, EDTA, and NAA) for 12 h.

The germination percentage and mean germination rate is highest when the seeds of *Citrullus lanatus* were primed by water treatment with value 96% & 1.71 in relative to the control (without treatment), NaCl, NAA and EDTA treatment with values of 88% & 1.57, 84% & 1.5, 60% & 1.07 and 28% & 0.5, respectively as indicated in Fig. 1 and 2 below. This might be due to faster water uptake by primed seed. Seeds primed by water could achieve earlier and more uniform germination, or by higher GI and longer and heavier

seedlings. Aliabadi *et al.* (2011) showed that the highest seedling vigor, germination percentage and seedling dry weight were achieved by hydro-priming after 12 h in Basil (*Ocimum basilicum* L). The findings of present study are in agreement with the results of Kaya *et al.* (2006) and Basra *et al.* (2006) who reported the seeds of sunflower and wheat primed by water could germinate faster and produced longer seedling under salinity stress, compared with untreated seeds. Although some earlier studies referred that seeds primed by salt solution can contribute to improve germination rate and seedling emergence in different plant species by increasing the expression of aquaporins (Gao *et al.*, 1999), enhancement of ATPase activity, RNA and acid phosphatase synthesis (Fu *et al.*, 1988), also by increase of amylases, protease or lipases activity (Ashraf and Foolad, 2005). In other words, salt solutions may lead to a better germination rate, but may be deleterious for muskmelon seed germination (Akers *et al.*, 1985).

Results showed that response to different priming technique as regards germination percentage and mean germination rate were approximately similar except for the NAA and EDTA treatment.

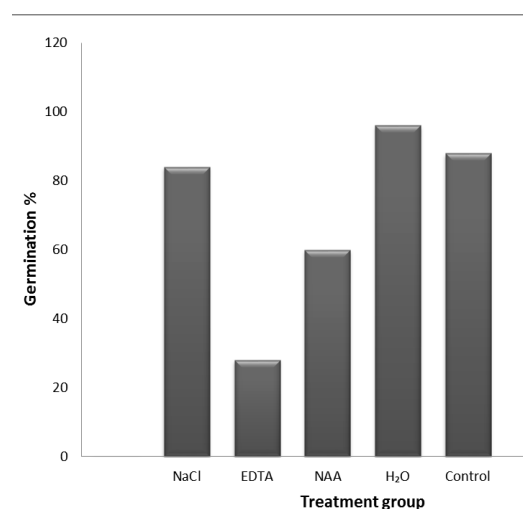


Fig. 1: Germination % of seeds primed by different treatment solutions

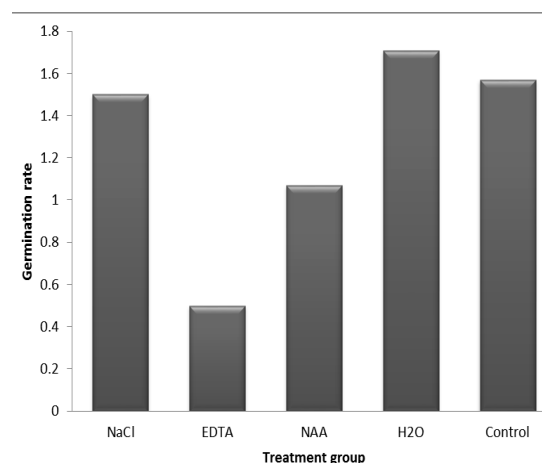


Fig. 2: Germination rate of seeds primed by different treatment solutions

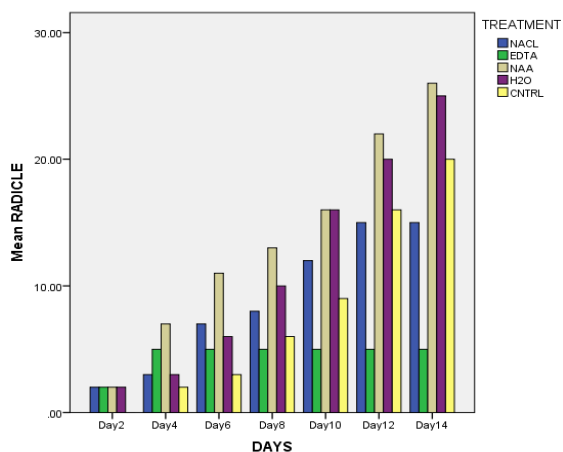


Fig. 3: Mean radicle lengths of seeds primed with different treatment solutions for 14 days

Maximum radicle length of *Citrullus lanatus* was also recorded for seeds primed by NAA treatment followed by water treatment (Fig. 3) though no significant ($P < 0.05$) difference of seed priming was observed on the length of the radicle. Protrusion of plumule was observed on the 8th day except for EDTA which there was no protrusion throughout the period of the experiment as indicated in Fig. 4. Maximum plumule length was noted in seeds primed in water followed by seeds not primed (control). However heavier seedling was achieved by seeds primed in water whereas minimum dry weight was recorded for seeds primed in EDTA solution with value that is insignificant as indicated in Table 1.

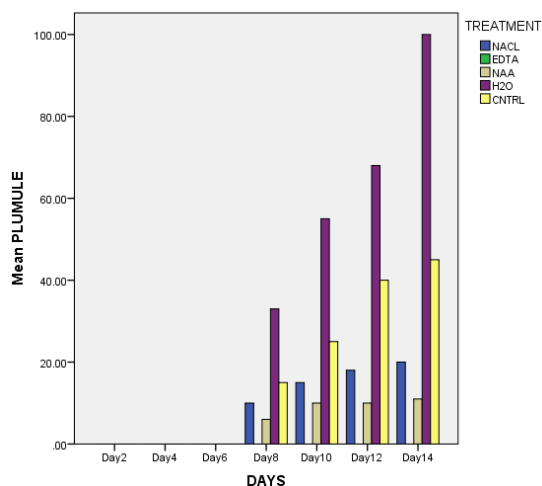


Fig. 4: Mean plumule lengths of seeds primed with different treatment solutions for 14 days

Table 1: Measurement of growth parameters of *Citrullus lanatus* in response to priming with different treatments

Seed Treatment	Seedling fresh weight (g)	Seedling dry weight (g)
NaCl	2.204 ^a	0.517 ^a
EDTA	0.00 ^{ac}	0.00 ^{ac}
NAA	2.030 ^a	0.386 ^{ab}
H ₂ O	3.138 ^{ab}	0.603 ^a
Control	2.295 ^a	0.504 ^a

* Values within a column having different alphabet superscripts are statistically significant ($P < 0.05$), according to Turkey's HSD post-hoc analysis

Results of this study showed that seeds primed by Ethylenediaminetetraacetic acid (EDTA) solution compared

with seeds primed by water and other treatments cannot be recommended as suitable treatment under both stress and non-stress conditions. It may be due to toxic effect of EDTA or might be because of long or low period of priming. More so, seeds primed by NaCl solution germinated better, possibly due to uptake of Na⁺ and Cl⁻ ions by the seed, maintaining a water potential gradient allowing water uptake during seed germination. According to Fredj *et al.* (2013), the best germination percentage of coriander (*Coriandrum sativum*) was obtained by soaking seeds in NaCl at 4 g/l for 12 h. 1-Naphthaleneacetic acid (NAA) is a synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rooting horticultural products; it is a rooting agent and used for the vegetative propagation of plants from stem and leaf cutting. It is also used for plant tissue culture (Morikawa and Takahashi, 2004). NAA solution was best in the radicle length and this may be because it is a rooting agent, though there is no significant difference among the radicle lengths of the treatment groups. However, there was poor growth of the plumule as compared with seeds primed by water. This may be as a result of the increased amounts of it which can actually have negative effects and thereby causing growth inhibition to the development of the plant crop.

Conclusions

The superiority of seeds primed by water on germination might indicate that applied water priming treatments did not damage seed structure or metabolic activity; hence, It may be concluded from present study that priming with water for 12 h was best than other priming media tested for high vigor and rapid seed germination.

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Conflict of Interest

None

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