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Germination and Seedling Performance of Watermelon as Affected by Chemo-priming

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Seed priming is a very important operation for healthy germination and seedling growth. Though a growing body of literature, the report on seed priming on watermelon is hardly available. Thus an experiment was conducted to study the germination and seedling performance of three watermelon cultivars viz. Asian 2, Pakorea F1 and Black Red with six seed priming treatments such as hydropriming with distilled water, halopriming with 1.5N NaCl and 3% KNO_3, osmopriming with 3% PEG (Polyethylene Glycol), oxidative priming with 0.1N HCl solution and control i.e. no priming.

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The seeds were primed overnight with the aforesaid liquids and were allowed to grow both in petridishes in dark condition within laboratory and in pot soil under natural condition in an open grill house. All three watermelon cultivars showed significant difference due to seed priming with aforesaid primers. Germination Index (GI) was found higher in Asian 2 and Black Red cultivars due to HCl priming and in Pakorea F1 due to NaCl priming, while priming with PEG and KNO_3 inhibited the GI of respective cultivars. Seedling Vigor Index (SVI) was found higher in Pakorea F1 with HCl priming whereas lower in Asian 2 and Black Red cultivars with PEG priming. Both in dark (Lab) and light (open field) conditions, total seedling dry matter was found higher in Asian 2 and Black Red cultivars due to HCl priming and lower in Pakorea F1 due to PEG priming. Results showed that low concentrated (0.1N) HCl solution can be used as priming medium to enhance germination and seedling growth of watermelon seeds.

Keywords: HCl; hydropriming; Osmotica; polyethylene glycol; primer; seed germination and seed priming; Vigour index.

1. INTRODUCTION

Watermelon (*Citrullus lanatus* L.) is a scrambling and trailing vine-like flowering plant species of the Cucurbitaceae family. It is a highly cultivated fruit and grown from tropical to temperate regions worldwide. Edible watermelon is a large fruit, which is a Berry with a hard rind and no internal divisions, and is botanically called a Pepo. The fruit can be eaten raw or pickled, and the rind is edible after cooking. It may also be consumed as juice or as an ingredient in mixed beverages. Watermelon is grown in 122 countries and around 1,200 cultivars are grown on all the continents globally (Tibor, 1993; Adeoye et al., 2011). China currently produces the largest quantity of watermelon, followed by Iran, Turkey and Brazil (FAO, 2017). In Bangladesh, watermelons are cultivated in about 15,740 hectares of land annually with a total production of 274,000 metric tons of watermelons with an average yield of 17.4 Mt/ha (Biswas, 2020).

Watermelon is cultivated in the various constraints in globally and also in Bangladesh where seed germination and early crop establishment is a major barrier such as hard soil crust, drought, excessive rainfall, water logging, nutrient deficiency and so on. However, no study on the effects of different priming agents or osmotica on the performance of watermelon seed germination and seedling growth has been reported especially in Bangladesh.

Priming is basically a physiological process in which the seeds are presoaked before planting which, by itself, allows partial imbibition though preventing the germination (Nascimento & Aragão, 2004). During the priming, several processes including activation and synthesis of a number of enzymes and nucleic acids, repair and build up of proteins, ATP synthesis, and the repair of cytoplasmic membrane will all start to develop in the treated seeds (Hosseini & Koocheki, 2007). Priming generally induces faster and more uniform seed germination especially in adverse physical conditions (Nascimento, 2007). It is nowadays being extensively used to improve seed germination and seedling emergence in a wide range of crop species (Hosseini & Koocheki, 2007). It is reported to practice in wheat, cabbage, pepper, muskmelon, mungbean etc. crop for better germination and early establishment of growing seedling in home and abroad (Aloui et al., 2014; Awal et al., 2024). Priming with some osmoticas was also reported to produce uniform and healthy seedling of watermelon (Sivritepe et al., 2003; Acharya et al., 2020). So far, no study is conducted on seed priming in watermelon in Bangladesh although initial establishment of plantlets of this crop is a tuff job at farmer's level. Therefore, the aim of the study is to find out the effects of priming with some chemical agents on seed germination and early seedling growth of watermelon.

2. MATERIALS AND METHODS

The study was conducted during the period from May 2019 to September 2019 in the Plant Ecology Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh, and in a grill house in open natural condition outside the Department (24°75' N latitude and 90°50' E longitude). The experiment comprised two factors. Factor A: six seed priming treatments such as (i) control (i.e. no priming), (ii) hydropriming with distilled water, (iii) halopriming with 1.5N NaCl, (iv) halopriming with 3% KNO_3, (v) osmopriming with 3% PEG (Polyethylene Glycol) 6000, and (vi) oxidative priming with 0.1N

HCl; Factor B: three watermelon cultivars viz. Asian 2, Pakorea F1, and Black Red. The experiment was laid out in a Factorial Randomized Block Design with four replications.

The watermelon cultivar Asian 2 is a F1 hybrid imported from Bangkok, Thailand. Pakorea F1 is a hybrid Korean cultivar which is marketed in Bangladesh by DAEIL Seed Co. Ltd. The variety Black Red originated from Thailand and is marketed by SEEDLINE Co. Ltd. Seeds of the aforesaid watermelon cultivars were collected from Dhaka and Mymensingh seed markets. Before using for investigation, the seeds were kept in chilled condition of -20°C in a refrigerator.

The priming was done by immersing seeds of each cultivar in 100 mL of respected priming solutions in 500 mL glass beakers, covered with aluminum foil and kept overnight (for 12h) (Acharya et al., 2020) at 20°C in aerated dark chamber. After 12 hours, primed seeds were rinsed with distilled deionized water for two minutes with an aim to wash-off the priming solutions from the surface of the seeds and then dried in room condition to the original moisture level and left overnight at room temperature to their original weight.

The clean and dried seeds were placed in the petridishes as per experimental design. The Whatman No. 1 filter papers were used for seed germination in the petridishes with 9 cm diameter. The petridishes were kept in a dark condition in the Laboratory. The seeds in the petridishes were observed daily and the number of seeds passed for germination was recorded. After completion of germination, the lengths and dry weight of plumule and radicle were recorded. The dry weight was determined by drying the seedlings in an oven at 80±2ºC till attained a constant weight.

Besides the seeds placed in the petridishes, the primed seeds were also sown in the pot soil in the grill house (open or natural condition) that is situated outside the Department. In each pot, 25 seeds from each cultivar were sown at a depth of 3 cm. The pots were saturated in water by surface irrigation. During plantlet growth, pots were irrigated daily by spraying with water until water would drain from the bottom of the pot. After complete emergence, lengths and dry weight of plumule and radicle were recorded.

Germination Index (GI) was calculated as the number of seed germination observed or counted that day is divided by the number of days after seed placement (Ranal et al., 2009):

$$GI = \sum Gt/Dt \qquad \text{Eq (1)}$$

where, Gt = is the number of germinated seeds on day t and Dt = is the time corresponding to Gt in days.

Seedling Vigor Index (SVI) was calculated following Abdul-Baki & Anderson (1973):

Seedling Vigor Index (SVI) = [Mean root length (L_r)+Mean shoot length (L_s)] × Percentage of seed germination (*GP*) Eq (2)

where, *GP* is the seed germination percentage (%), ratio of the number of germinated seeds to initial fifteen test seeds; L_r is the root length; L_s is the shoot length.

The collected data on different parameters were statistically analyzed to obtain the level of significance using MSTAT-C Package Programme. The mean differences were compared with Duncan's Multiple Range Test (Gomez & Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Germination Index (GI)

Germination Index (GI) showed significant differences for the priming treatments in all watermelon cultivars (Fig. 1). In Asian 2 variety, the GI was maximum in HCl and minimum in control treatment, while in Pakorea F1, the GI was higher in NaCl treatment and lower in KNO_3 treatment. The GI was higher in HCl and lower in PEG in Black Red cultivar.

An improvement in the germination process with seed pre-priming agents has been commonly reported in several crops. Ebrahimi et al. (2014) reported that the osmopriming may enhance the seed germination and growth rate of tomato cultivars under salt stress conditions. Batista et al. (2015) reported that both hydropriming and osmopriming improved germination and seed germination rate of pepper seeds compared to unprimed seeds. Matias et al. (2018) indicated that hydropriming improved tolerance of sunflower plants under saline environments. According to Kubala et al. (2015), the priming can improve germination rate through metabolic activation involving the synthesis of proteins, nucleic acids, and enzymes, and increasing water uptake, respiratory activity, and reserve mobilization.

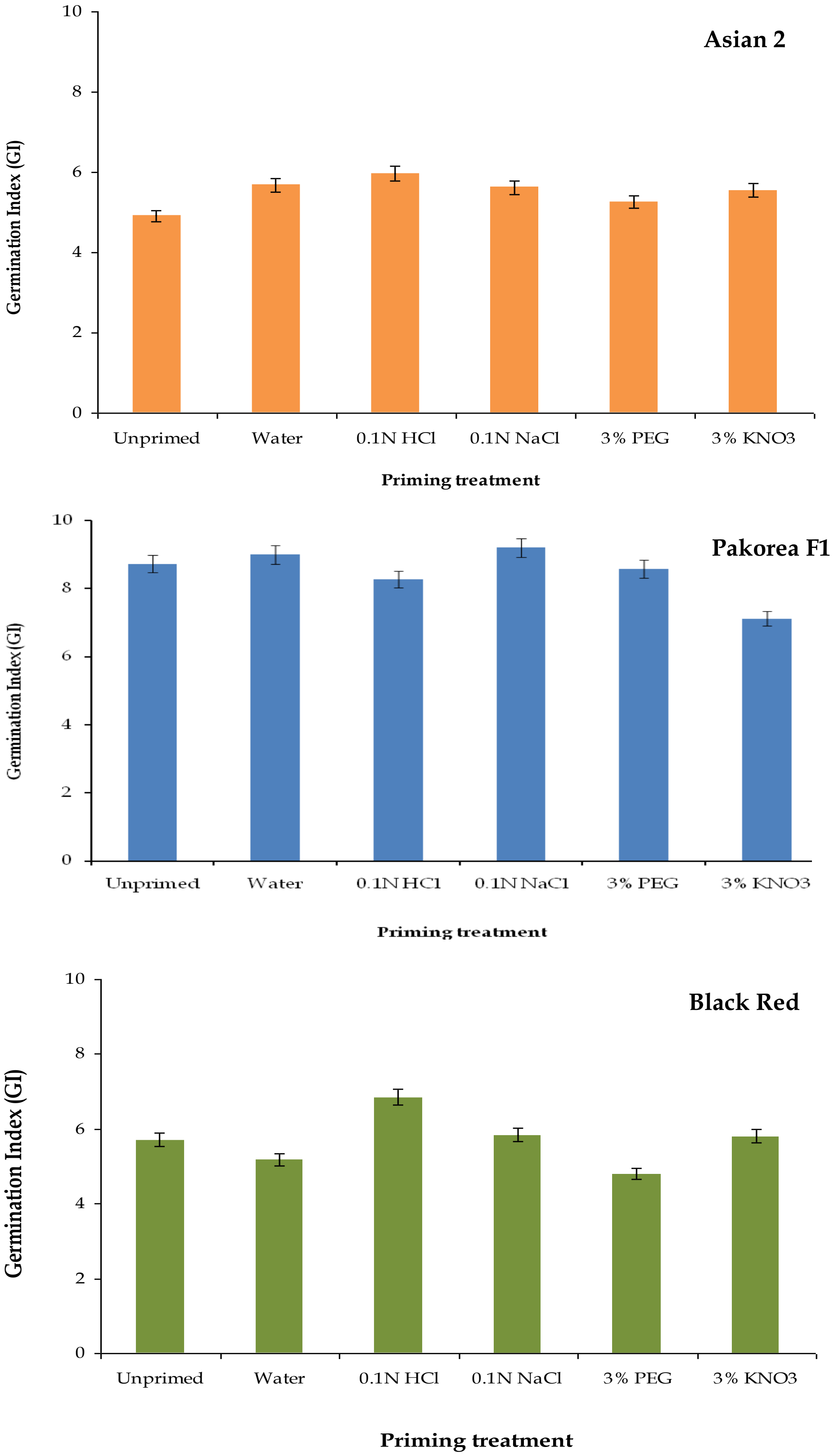

Fig. 1. Effect of seed priming on Germination Index (GI) in three cultivars of watermelon in Lab condition. HCl = Hydrochloric Acid, NaCl = Sodium Chloride, PEG = Polyethylene Glycol, and KNO_3 = Potassium Nitrate

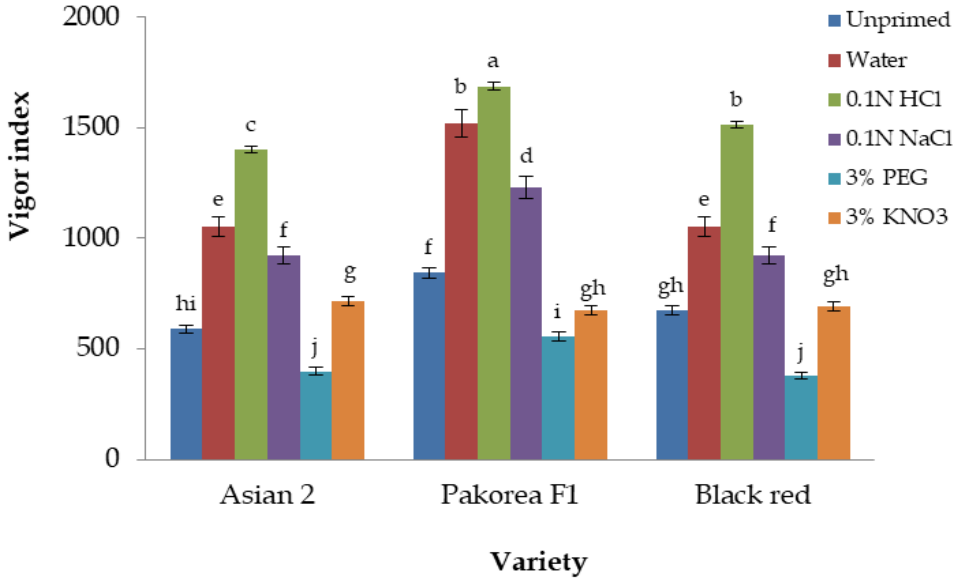

Fig. 2. Effect of seed priming on Seedling Vigor Index (SVI) in three watermelon cultivars in Lab condition. HCl = Hydrochloric Acid, NaCl = Sodium Chloride, PEG = Polyethylene Glycol, and KNO_3 = Potassium Nitrate

Germination rate of melon seeds was reduced with the increase of the salt stress level; however, this negative effect can be fully reversed with the hydropriming and osmopriming under mild salt stress. Under severe salt stress, the germination rate ranged from 0.99 to 3.10 seed day^{-1}, and was significantly greater when the seeds were primed with water, followed by KNO_3 priming, and lower for unprimed seeds (Oliveira et al., 2019).

3.2 Seedling Vigor Index (SVI)

Seedling Vigor Index (SVI) showed significant differences among the priming treatments in Asian 2, Pakorea F1 and Black Red cultivars. The results revealed that, SVI was maximum in Pakorea F1 with HCl treatment whereas minimum in Black Red cultivar with PEG treatment (Fig. 2). The HCl treatment also influenced the SVI in Black Red but not vary significantly in Asian 2. However, Asian 2 showed the maximum SVI with HCl treatment and minimum in PEG. In both Pakorea F1 and Black Red cultivars, maximum and minimum SVIs were observed in HCl and PEG, respectively.

Seedling vigor is a measure of the extent of damage that accumulates as viability declines, and the damage accumulates in seeds until the seeds are unable to germinate and eventually die (Kaya et al., 2006; Farhoudi et al., 2007; Marcos-Filho, 2015). VI is used as a phytotoxicity index to evaluate the effect of heavy metal, chemical etc. on seedling growth (Srivastava & Thakur, 2006; Kabir et al., 2008). Salehzade et al. (2009) showed that osmopriming improved germination and seedling vigor than that unpriming in wheat (*Triticum aestivum* L.). Mamun et al. (2018) found that priming agent exerted significant effect (p <0.01) on seed germination rate, germination pattern and seedling vigor of winter rice. In general, seed priming showed a positive effect on seed germination and seedling vigor of winter rice. NaCl at any concentration reduced emergence rate, while $CaCl_2$ priming enhanced germination rate the most. Priming with $CaCl_2$, KCl and PEG found the best for germination index, while $CaCl_2$, KCl and $CuSO_4$ mostly results the vigorous seedlings (Zheng et al., 2016). Seed priming with KNO_3 can cause a significant increase in seedling vigor of the wheat crop as compared to hydro-priming or dry broadcasting (Basra et al., 2003).

3.3 Seedling Dry Weight

Seed priming showed significant influence on the total dry weight of watermelon seedling (Fig. 3). There was significant variation among the priming agents. In all three watermelon cultivars, total dry weight was found higher due to HCl priming and lower due to PEG priming both in dark condition under Laboratory and pot sowing conditions in natural outside.

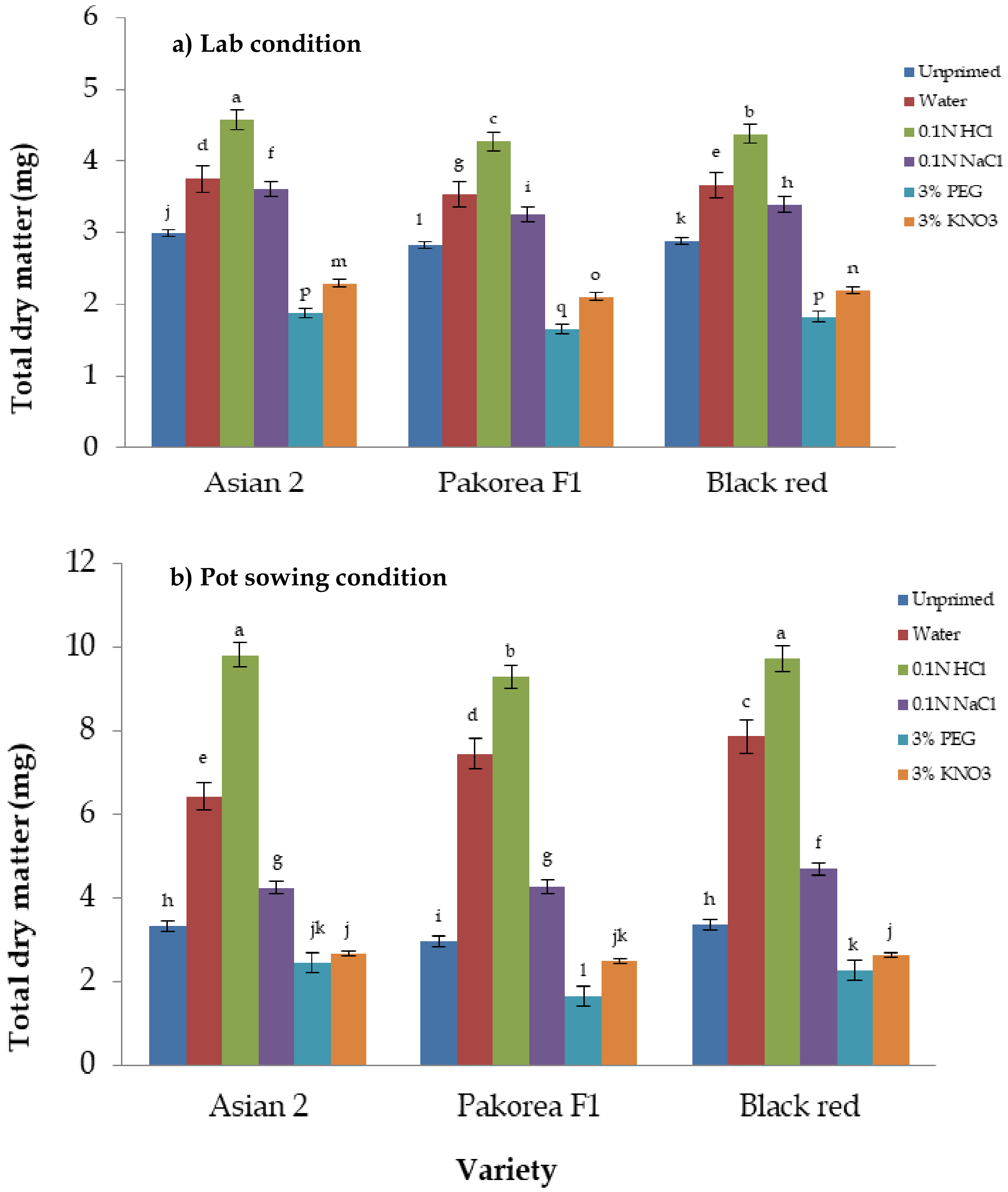

Fig. 3. Effect of seed priming on total dry weight of watermelon in Lab (upper) and pot sowing (below) condition. HCl = Hydrochloric Acid, NaCl = Sodium Chloride, PEG = Polyethylene Glycol, and KNO_3 = Potassium Nitrate

Oliveira & Steiner (2017) reported that inhibiting action of salt stress on the initial growth of cucumber seedlings was increased with the rise of salinity levels, and the exposure of seeds to severe salt stress decreased the total dry matter. Acosta-Motos et al. (2007) showed that the total dry matter production severely inhibited by salinity; however, this effect was fully reversed with the use of seed priming with water or KNO_3. This showed that seeds primed with water or KNO_3 may adjust the salinity stress.

4. CONCLUSION

It may be concluded that seed priming with HCl showed better and priming with PEG showed poor germination, seedling vigour and dry matter production in all three watermelon cultivars studied both in dark condition under laboratory and pot sown under open natural condition. So, low concentrated (0.1N) HCl solution can be used as best seed primer to enhance germination and seedling growth of watermelon seeds.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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