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ORIGINAL ARTICLE

The Effect of Seed Priming on Germination and Seedling Growth of Watermelon *(Citrullus Lanatus)*

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Mohammad Armin, Mohammad Asgharipour and Mohammad Razavi-Omrani: The Effect of Seed Priming on Germination and Seedling Growth of Watermelon *(Citrullus Lanatus)*

ABSTRACT

Seed priming is a pre-sowing treatment which involves a controlled hydration of seeds, sufficient to allow pre-terminative metabolic events to take place while insufficient to allow radicle protrusion through the seed coat. This technique has been used to increase the germination rate, total germination and seedling uniformity, mainly under unfavorable environmental conditions. Little information is available about seedling development of watermelon to seed priming in field condition. To investigate the effect of seed priming on germination and seedling growth of watermelon, an experiment was conducted at Azad University of Sabzevar with factorial arrangement of treatment in a completely randomized design with 3 replications. Experimental factors were 3 watermelon cultivars (Niagara, Charleston Gray, and Crimson Sweet) and 5 priming media (HCL 0.1N, NaCl 1.5N, PEG 6000 3%, KNO_3 3%, and none primed). Priming increased watermelon emergence, emergence rate, and plumule length. No significant differences were found to exist on plumule dry weight and radicle length. Priming with PEG and NaCl negatively affected the rate and growth of emerged seedling. Among the assessed priming media, KNO_3 had the most effective impact on emergence and seedling growth. Compared with the non-primed seeds, seed priming with KNO3 increased the germination, germination rate and plumule length by 17.87%, 18.65%, and 4.68%, respectively.

Key words: germination, priming, KNO_3, cultivars, watermelon

Introduction

Seed priming is nowadays being extensively used to improve seed germination and seedling emergence in a wide range of crop species[3] and is basically a physiological process in which the seeds are pre-soaked before planting which, by itself, allows partial imbibition though preventing the germination[7]. During the priming, several processes including storage, material handling, activation and synthesis of a number of enzymes and nucleic acids, repair and build up, ATP synthesis, and the cytoplasmic membrane repair in treated seeds will all start to develop[3].

Osmo-priming is a commonly used method for priming the seeds. Priming generally induces faster and more uniform seed germination especially in adverse physical conditions of many crop species [6]. Sivritepe *et al.*[9] indicated that watermelon seeds priming with 1% NaCl for 3 day at 20 °C reduced salinity effects on germination of watermelon and increased watermelon tolerance to salinity in the early stages of growth. Jian Jun *et al.*[4] investigated effects of different osmotics which can be used in seed priming on watermelon germination and reported that priming with solutions of copper sulfate 1% for 4 h and zinc sulfate 0.2% for 24 h will enhance germination by respectively 17.1% and 73.3% compared with untreated seeds. Mavi (2004) evaluated the effects of osmo-priming (using solution

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of potassium nitrate for 6 days at 24°C) and hydro-priming (using distilled water with temperature of 30°C for 18 days) on watermelon germination under 3 different temperatures of 15, 25, and 38°C, coming to conclusion that no significant impact of osmo-priming and hydro-priming would be found between 25 and 38°C on seed germination. It was however, significantly increased in seed germination when using 15°C for both osmopriming and hydropriming. The beneficial effects of osmo- and hydro- primings are associated with increase in radicle and plumule lengths.

Priming also enhances the crop establishment in filed. Manigopa *et al.*[5] reported that priming in chickpea (*Cicer arietinum* L.) led to better crop establishment and growth and greater yield. Seed priming increased the number of plants at harvest, yield, germination, number of pods per plant, number of lateral branches per plant, and number of seeds per plant by respectively 12.8%, 9.6%, 9.4%, 6.4%, and 6.5%, over the non-priming treatment.

Hosseini and Koocheki[3] stated that in sugar-beet seed, different varieties can respond differently to priming. According to their data, the variety to be responded better over a wide range of varieties was K.V.S. The response of seeds to priming has been found to be dependent on the osmitica, duration of priming, seed maturity, cultivar, and environmental conditions[6].

Melon is an important horticultural crop cultivated mostly in arid and semi-arid region of the world where salinity, high temperature, rapid soil drying, and crust formation are barriers to good melon crop establishment. However, no study has been previously reported in the context of Iran on the effects of different osmotica on melon seed germination and early seedling growth. Consequently, the aim of this study was to elucidate the effects of osmo-priming on seed emergence and early seedling growth of watermelon under the same conditions on the farm.

Materials and Methods

The effects of osmo-priming on watermelon (*Citrullus lanatus*) seed germination and early seedling growth was investigated via a laboratory emergence test. The experiment was conducted with factorial arrangement of the treatment in a completely randomized design with 3 replicates. Experimental factors were 3 watermelon cultivars (Niagara, Charleston Gray, and Crimson Sweet) and 4 different osmotic solutions (0.1N Hydrochloric acid, 1.5N NaCl, 3% polyethylene glycol (PEG) 6000, 3% KNO_3).

Three popular watermelon seeds (Niagara, Charleston Gray, and Crimson Sweet) were obtained locally. One hundred randomly selected seeds placed in a 10-cm diameter plastic Petri dish on a filter paper (Whatman filter paper No. 1). The Petri dishes were then covered by aluminum foil in order to prevent waste solution and were placed in a germinator (with a temperature of 20 °C and in constant darkness) and a period of 6 days was allocated to their growth. After the 6 days, seeds were rinsed in distilled deionized water for 2 minutes with an aim to wash off the solutions from the surface of the seeds, and were slowly dried at room temperature for 48 hours back to their original (non-primed) moisture content as described in Demir and Mavi (2004). Unprimed seeds were used as control. Glasshouse experiments were carried out to compare the actual performance of the seed subjected to different priming treatments at Azad University of Sabzevar, Sabzevar, I. R. Iran. In each pot (sized 32 * 22* 6 cm, and filled with sand loamy soil), 25 seeds from each variety were sown at a depth of 3 cm. The pots were saturated in water by surface-irrigation. During plant growth, pots were irrigated daily by spraying with water until water would drain from the bottom of the pot. Germination was measured daily for 18 days between 9 AM to 10 AM. Five seedlings were randomly harvested from each pot to determine plumule length, radicle length and plumule dry-weight of seedlings. The glasshouse temperature was maintained between 24 and 15 °C for days and nights, respectively.

Final germination-percent and mean germination-time were calculated according to the equation below [6]:

$$\text{Final germination percent} = \frac{T}{S} * 100$$

$$\text{Mean germination time} = \sum \left(\frac{N_i * 100}{D_i} \right)$$

where T is the number of germinated seeds, D_i is the number of days after starting the experiment, and S and N_i represent the total number of planted seeds and of the germinated seeds on the ith day, respectively.

For the analysis of variance and to determine the significant differences between treatments, the SAS computer package (SAS Inc V 9.1) was used. Duncan’s multiple-range test was applied for comparing the treatment means.

Results and Discussion

Final germination percentage:

No statistically significant differences ($p<0.05$) have been found to exist between the varieties on final germination percentage (Table 1). Charleston Gray had the greatest final germination percentage, while Niagara had the least final germination percentage (Table 2).

Different priming treatments significantly ($p<0.05$) influenced the final germination percentage (Table 1). Among the assessed osmotica, Potassium Nitrate had the most effective impact on the final germination-percent of sugar-beet seeds which increased the germination by 17.87% compared with that of the control (Table 3).

Positive effects of different solutions on final germination-percentage can be due to overcoming the seed dormancy or to improving the embryonic activity during germination. Observed decrease in the seeds treated with sodium chloride and PEG ,too, can be due to osmotic and ionic effects of ions of these two materials, which led to less water uptake and lower germination percentage by seeds.

These results are in line with Demir and Mavi (2004), who found increased germination and mean germination time of watermelon seeds treated with potassium nitrate.

Mean germination time:

Mean germination-time significantly changed between different varieties (Table 1). Charleston Gray exhibited the greatest mean germination-time, while Niagara had the least one (Table 2). It seems that higher storage materials in seeds may lead to greater mean germination-time in Charleston Gray.

There was a significant difference between different priming treatments in mean germination-time (Table 3). As it can be seen, mean germination-time followed a trend similar to final germination-percent. Seeds primed in Potassium Nitrate solution had the highest mean germination-time, followed by Hydrochloric acid, while priming with solutions of Sodium Chloride and PEG significantly declined this parameter over the control (Table 3). The results of this study are consistent with those of Hosseini and Koocheki[3], who reported that priming with solutions of Sodium Chloride and PEG significantly decreases mean germination-time in different varieties of sugar-beet.

Postponement in germination can be a result of the osmotic pressure and reduced water absorption by seeds. In the present study, negative effects of polyethylene glycol were greater than those of sodium chloride. In melon, it has also been reported that primed seed in salt solutions germinated faster compared with in PEG or in mannitol. The increased MET in primed seeds in the PEG than in sodium chloride could possibly be due to the fact that the melon seeds released some ions like K+ from seed embryos by Prisprm, and this, by itself, resulted in being less affected in saline solutions than in PEG (Nascimento and West, 1999).

Sung and Chiu[10] found that in primed watermelon seeds, faster germination depends on the weight and thickness of seeds. Seed priming by softening the seed coat reduces the restrictions to radicle protrusion through the seed coat. One of the reasons for low germination in watermelon seeds is stiffness of its seed coat.

Plumule length:

Analysis of variance revealed that plumule length was affected by different priming treatments, whereas plumule length was not significantly different across varieties (Table 1). Trend of observed changes in plumule length across priming solution were similar in plumule length and MET.

Priming with solutions of potassium nitrate and acid hydrochloric exhibited the greatest plumule length, while priming with PEG had the least plumule length (Table 3). Faster seed-germination can cause greater plumule length in seeds treated with potassium nitrate and acid hydrochloric. Nascimento [6], too, has reported that the pre-treatment of melon seeds with different solutions increased plumule length resulted from the longer period of time for seedling growth as a result of a faster germination.

Plumule dry weight:

Plumule dry-weight was affected by varieties and different osmotica (Table 1). The greatest plumule dry-weight was observed in Charleston Gray (Table 2). The Charleston Gray was also superior in other characteristics compared to other varieties. Faster germination provided more time for seedling growth in this variety, which leads to a higher dry-weight of Charleston Gray plumule. The effect of different Priming treatments on the dry-weight of plumule is given in Table 3. As it was expected, primed seed in Potassium Nitrate and PEG exhibited the greatest and the least plumule dry-weights, respectively.

Radicle length:

No statistically significant differences were found to exist between the varieties and the different priming treatments on radicle lengths, whereas the interaction of cultivar * priming treatment on radicle length was significant (Table 1). Trend of radicle length in different cultivars revealed that the greatest radicle length in Charleston Gray occurred when seeds primed with Potassium Nitrate solution, while in Niagara seed priming with hydrochloric acid caused the highest radicle length. Primed seed in all three studied varieties had the least radicle lengths when primed with Sodium Chloride and PEG. Studies on the sugar-beet showed that seed pre-treatment with Sodium Chloride and PEG, compared with distilled water, decreased the radicle length[3].

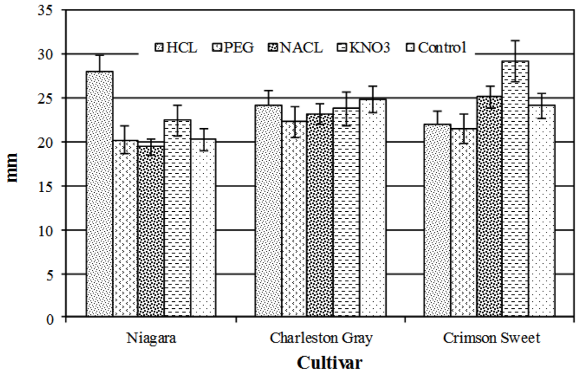

Fig. 1:

Table 1: Analysis of variance table for the final germination percentage, mean germination time, plumule length, radicle length and plumule dry weight of watermelon seedlings.

	Studied traits				
SOV	Final Germination percentage	Mean germination time (day-1)	Plumule length (mm)	Plumule dry weight (mg)	Radicle length (mm)
Cultivar	ns	0	ns	ns	ns
Priming	0	**	0	ns	ns
Cultivar* Priming	ns	ns	ns	ns	0

ns: not significant; (*) and (**) represent significant difference over control at P < 0.05 and P < 0.01, respectively.

Table 2: Effect of verities on final germination percentage, mean germination time, plumule length, radicle length and plumule dry weight of watermelon seedlings.

	Studied traits				
Cultivar	Final Germination percentage	Mean germination time (day-1)	Plumule length (mm)	Plumule dry weight (mg)	Radicle length (mm)
Niagara	92.14a	4.89b	148.1a	0.131a	21.9a
Crimson Sweet	94.9a	5.02ab	149.04a	0.154a	24.1a
Charleston Gray	96.39a	5.32a	154.7a	0.153a	24.3a

* Values followed by the same letter within the same columns do not differ significantly at P = 5% according to DMRT.

Table 3: Effect of priming treatments on final germination percentage, mean germination time, plumule length, radicle length and plumule dry weight of watermelon seedlings.

priming media	Final Germination percentage	Mean germination time (day-1)	Plumule length (mm)	Plumule dry weight of (mg)	Radicle length (mm)
Hydrochloric acid	94.35a	5.24a	155.56ab	0.145a	24.37a
PEG	55.25c	3.21c	140.95b	0.141a	21.26a
Sodium chloride	64.73bc	3.42c	141.62b	0.137a	22.70a
Potassium nitrate	96.74a	5.47a	161.26a	0.156a	25.44a
Control	79.45b	4.45b	153.71ab	0.141a	23.53a

* Values followed by the same letter within the same columns do not differ significantly at P = 5% according to DMRT.

Conclusion:

Results of the present investigation with osmo-priming of three popular watermelon varieties using four different osmotic solutions showed that the priming solutions regarded as advisable are: potassium nitrate and hydrochloride acid. Similar responses in germination among different varieties may be due to genetically similar varieties investigated in this experiment.

References

1. Demir, H. and K. Mavi, 2004. Seed priming of male sterile muskmelon (*cucumis melo* L.) for low temperature germination. Seed Science and Technology, 23(4): 881-884.
2. Demir, I., H.A. van de Venter, 1999. The effect of priming treatments on the performance of watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai) seeds under temperature and osmotic stress. Seed Science and Technology, 27(3): 871-875.
3. Hosseini, A. and A. Koocheki, 2007. The effect of different priming treatments on germination percent and mean germination time of four varieties of sugar beet. Journal of Agronomic Research, 5(1): 69-76.
4. Jian, J.F., C.K. Jie, K.J. Yoen, X. Yong, Z.X. Yang, L.J. Qiang, 2007. Effect of seed priming on seedling growth and disinfection to *Acidovorax avenae* Subsp. Citrulli in triploid watermelon seeds. Acta Phytopathologica Sinica., 37(5): 528-534.

5. Manigopa, C., J. Ghosh, D.S. Virk, S.C. Prasad, 2007. Effect of seed priming on germination, growth and yield of horsegram cultivars. Journal of Arid Legumes, 4(1): 56-58.
6. Nascimento, W.M., 2003. Muskmelon seed germination and seedling development in response to seed priming. Scientia Agricola, 60(1): 71-75.
7. Nascimento, W.M. and F.A.S. Aragão, 2004. Muskmelon seed priming in relation to seed vigor. Scientia Agricola, 61(1): 114-117.
8. Sivritepe, H.O., N. Sivritepe, A. Eris and E. Turhan, 2005. The effects of NaCl pre-treatments on salt tolerance of melons grown under long-term salinity. Scientia Horticulturae, 106: 568-581.
9. Sivritepe, N., H.O. Sivritepe, A. Eris, 2003. The effects of NaCl priming on salt tolerance in melon seedlings grown under saline conditions. Scientia Horticulturae, 97: 229-237.
10. Sung, J.M., K.Y. Chiu, 1995. Hydration effects on seedling emergence strength of watermelon seed differing in ploidy. Plant Science, 110: 21-26.