Research Article
Journal of Agricultural Biotechnology (JOINABT) 2(1), 1-5, 2021
Recieved: 12-Apr-2021 Accepted: 19-Apr-2021

SAKARYA UNIVERSITY
OF APPLIED SCIENCES

Effect of Hydro-Priming on Seed Germination and Early Seedling Growth in Three Cucurbit Rootstock Cultivars under Salt and Osmotic Stresses

Sıtkı Ermiş[1], Güleda Öktem[1], Zeynep Gökdaş[2], Ibrahim Demir[2*]
[1] Variety Registration and Seed Certification Center, Ankara, Turkey.
[2] Department of Horticulture, Faculty of Horticulture, University of Ankara, Turkey.

ABSTRACT

In this study, the effects of hydro-priming was assessed to enhance germination and seedling growth of three cucurbit rootstock cultivar (Nun 9075, Shintosa and Jumbo) seeds. Seeds were soaked at 25°C over 24 hours in the dark, hydro-primed and control seeds were then germinated at 100 mM NaCl, salt and -0.6 MPa Polyethylene glycol (PEG-6000), osmotic stress conditions. Germination percentages, mean germination time, root length, root fresh and dry weight, seedling fresh and dry weights were measured after 7 days-old seedlings. Results showed that hydro-priming increased germination percentages and seedling growth parameters under both stress conditions in all three cultivars. The findings suggested that hydro-priming can be an effective method to increase germination potential and seedling growth in rootstock cultivar seeds.

Keywords: *Seed treatments, rootstock seeds, cucurbit, hydro-priming, stress conditions.*

Hidropriming Uygulamasının Farklı Anaç Kabak Tohumlarında Tuz ve Ozmotik Stres Altında Çimlenme ve Erken Fide Gelişimi Üzerine Etkileri

ÖZ

Bu araştırmada, farklı kabak anaç çeşitlerine ait tohumlarda (Nun 9075, Shintosa ve Jumbo) hidropriming uygulamalarının tohum çimlenmesi ve fide gelişimi üzerine etkileri araştırılmıştır. Tohumlar karanlık bir ortamda 25°C sıcaklıkta 24 saat boyunca suda bekletilmiştir. Hidropriming uygulanan tohumlar ve kontrol grupları daha sonra 100 mM NaCl, tuz ve -0.6 MPa Polietilen glikol (PEG-6000) ile sağlanan osmotik stres koşullarında çimlendirilmiştir. 7 gün sonra çimlenme yüzdeleri, ortalama çimlenme hızı, kök uzunluğu, yaş ve kuru sürgün ve kök ağırlıkları ölçülmüştür. Hidropriming uygulaması sonucunda, anaç kabak çeşitlerine ait tohumların çimlenme yüzdelerinin ve fide gelişim parametrelerinin her iki stres koşulunda arttığı görülmüştür. Elde edilen bulgular hidropriming uygulamasının, kabak anacı çeşitlerinin tohumlarında çimlenme potansiyelini ve fide gelişimini arttırmada etkili bir yöntem olabileceğini göstermiştir.

Anahtar Kelimeler: *Tohum uygulamaları, anaç tohumlar, kabakgiller, hydro-priming, stres koşulları*

1. Introduction

Germination and seedling growth are critical period in the life of a plant and are susceptible to various abiotic stresses. Salinity and drought are major abiotic stresses that limit the growth and production of plant [1, 2]. Stressful conditions are more detrimental in seed germination period than subsequent developmental stages. Grafted seedling production in cucurbits as watermelon, marrow, are a common practice and various rootstock cultivars are used to increase the resilience of the plant to soil borne diseases such as Fusarium spp. or abiotic stresses as salt [3, 4]. One common problem in rootstock seed germination is slow germination due to the environmental constraints which resulted in smaller sized

* Corresponding Author's email: demir@agri.ankara.edu.tr

seedlings and reduce efficacy of grafting. Therefore, obtaining fast and efficient germination of rootstock seeds under stressful environment is important issue for successful grafted transplant production [5, 6, 7].

Two major environmental factors i.e. salt and drought stresses inhibit seed germination and delaying seedling establishment. Drought decreases water uptake during imbibition. Among various strategies to increase salt and drought tolerance in crop seeds hydro-priming was proved to be an efficient method to improve germination percentages and early seedling growth in various vegetable seeds [8, 9]. It was reported that it is a low-cost, simple and effective technique for suitable application for seed quality enhancement [8, 10]. There are reports on the benefits of hydro-priming in cucurbit seeds [11, 12]. However, studies on rootstock seeds are scarce. Grafted seedling production is a high-cost and requiring specific production techniques. Therefore, the positive outcome of priming is more valuable in such systems. The most common rootstocks for cucurbits are wild watermelon (*C. lanatus* var. *citroides*), bottle guard accessions (*Lagenaria scecaria*), cucurbita interspecific hybrids (*C. maxima* x *C. moschata*). Interspecific hybrids are most widely used due to their high resistance to soil-borne fungi. Rootstock seeds are hybrids (i.e. *C. maxima* x *C. moschata*) and may likely to have a different response to priming treatments than open-pollinated cultivars due to their interspecific genetic structure. Moreover, faster germination through priming ensure well-developed seedlings which provide more efficient grafting at one time [5].

The objective of the present study was then to evaluate the effects of hydro-priming on seed germination and seedling growth in cucurbit rootstock seeds grown under salt and drought stresses.

2. Material and Method

This study was carried out on *C. maxima* x *C. moschata* interspecific hybrid cultivars of Nun 9075 from Nunhems B.V, Shintosa F-90 from Semillas Fito and Jumbo from AG Seeds are widely used as watermelon rootstock in Turkey. Seeds were stored at 4°C until use. Initial seed moisture content was determined according to the high temperature oven method [13].

Table 1. Total and normal germination, seed moisture content, 1000 seed weight of three hybrid rootstock cultivars (*C. maxima* x *C. moschata*) inbred lines

Cultivar	Germination (%)		Seed m.c (%)	1000 seed weight (gr)
	Total	Normal		
Nun 9075	93	87	6.37	227
Shintosa	93	72	5.70	184
Jumbo	88	69	6.17	221

For hydro-priming, seeds were soaked in distilled water at 25°C for 24 h under dark conditions. Following priming, the seeds were rinsed under distilled water for 30 seconds. Thereafter, the treated seeds were surface-dried with paper towels.

Three replicates of 25 seeds of each cultivar were placed in 20x13 cm sealed plastic germination boxes on doubled-layered paper towels moistened with 100 mM NaCl and -0.6 MPa PEG-6000 solution (10 ml/paper). The germination papers were moistened with NaCl and PEG-6000 solutions as needed. These doses were selected according to our preliminary results. The germination test was executed at 25°C in the dark and the percentage two mm radicle germination (total germination) was determined using daily counts for 8 days. Normal seedling percentages were assessed at the end of the germination test. Stress germination values were presented as normal germination values.

Mean germination time (MGT, days) was calculated according to the formula below,

$MGT = \sum n.t / \sum n$ where n = number of newly germinated seeds (2 mm radicle emerged) at time t,

t = days from planting, and $\sum n$ = final radicle germination

In the end of experiment; root length (cm/plant), root fresh (g/plant) and root dry weight (mg/plant) seedling fresh (g/plant) and dry weight (mg/plant), were determined on all germinated seedlings at the end of the germination test. The dry weights were determined after drying the samples at 80°C for 24 h. All data presented are the mean values.

Statistical analysis was carried out by using independent samples t-test significance of the difference between means. Means were considered significantly different for $P<0.05$.

3. Results and Discussion

Germination percentages, mean germination time, and seedling growth parameters were negatively affected by salt and osmotic stresses (Tables 2, 3 and 4) in all three cultivars. The response of the cultivars to stresses varied. Nun 9075 was not affected as much as the other two cultivars. Un-treated Shintosa and Jumbo cultivars had below 41% of germination under stress conditions. But treated ones had between 43 and 60% (Table 2). Salinity and drought stress are common abiotic stresses that effect seed germination in various crop seeds [14] but the response differs according to the species and cultivars.

This can be due to the genetic background and also differences initial seed quality level. Rootstock seeds are inbred hybrids which might have various genetic background. Moreover, it was reported that higher quality seed lots i.e. more mature ones have more resilience to salt and osmotic stresses than those of inferior quality ones [1]. It can be considered that pre-treatment quality of the seed lot has also an importance in the benefits that obtained from priming treatment [15]. Nun 9075 has higher initial seed germination which can be an advantageous in stress resilience.

Table 2. Changes in normal germination (NG) and mean germination time (MGT) of control (C) and hydro-primed (HP) seeds of three cucurbit rootstock cultivars at salt (NaCl) and drought (PEG) conditions.

Cultivar	App	Germination		MGT	
		C	HP	C	HP
NUN 9075	NaCl	37	75*	3.08	1.87*
	PEG	50	63	3.61	2.07*
Shintosa	NaCl	18	55*	4.22	3.36*
	PEG	6	43*	6.09	3.75*
Jumbo	NaCl	41	60*	2.84	2.58
	PEG	26	57*	5.60	3.42*

* indicates the significant differences based on t-test (95% S.D.) in each cultivar and stress conditions, App: Application

In all cases MGT was reduced significantly ($p<0.05$) by the treatment except in NaCl in Jumbo (Table 2). Root length, fresh weight and dry weight were increased by hydro-priming in all three cultivars (Table 3). Rapid emergence, lower mean germination time, and strong early seedling growth are crucially important to get a better and timely field establishment [16] and developed transplant production [17] since faster germination was significantly related to larger seedling size.

Table 3. Changes in root length (mm/plant), fresh weight (mg/plant) and dry weight (mg/plant) of control (C) and hydro-primed (HP) seeds of three cucurbit rootstock cultivars at salt (NaCl) and drought (PEG) conditions.

Cultivar	App	Root length		Root fresh weight		Root dry weight	
		C	HP	C	HP	C	HP
NUN 9075	NaCl	11.1	13.7	4.09	7.38*	0.39	0.54*
	PEG	9.4	12.0	1.12	2.51*	0.19	0.25
Shintosa	NaCl	6.4	10.0*	2.43	4.58*	0.25	0.36*
	PEG	4.8	10.1*	0.25	0.79*	0.03	0.14*
Jumbo	NaCl	9.0	10.7	4.15	4.47	0.35	0.39
	PEG	4.2	9.8*	0.79	1.65	0.12	0.23*

* indicates the significant differences based on t-test (95% S.D.) in each cultivar and stress conditions, App: Application

Hydro-priming increased seedling fresh and dry weight in all three cultivars (Table 4). The highest seedling fresh and dry weight were observed in Nun 9075 in both stress conditions. This cultivar is the largest seed sized cultivar of all. This may be one reason to initiate the faster germination. Taylor and Ten Broeck [18] reported that energy content of any seed can be related to amount of stored material within the seeds. Higher amount of stored material in this cultivar would be used to generate more energy to split seed coat. The effect of larger seed size was also seen in watermelon in which diploid cultivars had larger seedlings than triploid (small size) [12]. This appears to be influential under stressful environments (Table 2, 3, 4).

Table 4. Changes in seedling fresh weight (g/plant) and dry weight (g/plant) of control (C) and hydro-primed (HP) seeds of three cucurbit rootstock cultivars at salt (NaCl) and drought (PEG) conditions.

Cultivar	App	Seedling fresh weight		Seedling dry weight	
		C	HP	C	HP
NUN 9075	NaCl	8.1	12.5*	2.8	3.2*
	PEG	4.4	5.4	2.8	3.2
Shintosa	NaCl	5.4	8.4*	2.3	2.4
	PEG	0.9	3.3*	0.6	2.0*
Jumbo	NaCl	6.7	9.7*	2.3	2.4
	PEG	3.6	4.1	2.3	2.3

* indicates the significant differences based on t-test (95% S.D.) in each cultivar and stress conditions

Results of present study indicated that hydro-priming improved seedling parameters. Strong development in root and shoot system is a prerequisite for success in grafting. The larger root size obtained by priming under stressful conditions may be advantageous to get stronger seedlings under stress i.e. higher water uptake. Hydro-primed seeds had shorter germination time and better root growth which is in agreement with earlier reports [11, 16]. This indicates that hydro-priming alleviates the negative effect of reduced water potential gradient which imposed by salt and drought stress and inhibits primary root protrusion [19]. While optimization of priming technique to achieve best results is another necessity since factors such as treatment duration, temperature, water potential and seed vigour level may determine seed response to priming [20].

As conclusion hydro-priming as a cheap, quick, practical pre-sowing method can be used to enhance rootstock seed germination and early seedling size under salt and drought stress. That will be a practical approach to improve seedling quality of cucurbit rootstock seeds and in turn improve grafting potential of seedlings.

References

[1] Demir, I., and Mavi, K. (2008). Effect of salt and osmotic stresses on the germination of pepper seeds of different maturation stages Brazilian Archives of Biology and Technology 51 (5) 897-902.

[2] Farooq, M., Wahıd, A., Kobayashı, N., Fujita, D., and Basra, S. M. A. (2009). Plant drought stress: effects, mechanisms and management. Agron. Sustain. Dev. 29, 185-212.

[3] Yetisir, H., and Sari, N. (2003). Effect of different rootstock on plant growth yield and quality of watermelon. Australian Journal of Experimental Agriculture 43, 1269-1274.

[4] Passam, H. C., Stylianou, M., and Kotsiras, A. (2005). Performance of eggplant grafted on tomato and eggplant rootstocks. European Journal of Horticultural Science 70, 130-134.

[5] Mavi, K., Ermis, S., and Demir, I. (2006). The effect of priming on tomato rootstock seeds in relation to seedling growth. Asian Journal of Plant Sciences 5 (6) 940-947.

[6] Schwarz, D., Rouphael, Y., Colla, G., Venema, J. H. (2010). Grafting as a tool to improve tolerance of vegetables to abiotic stresses: Thermal stress, water stress and organic pollutants. Sci Hortic 127:162–171.

[7] Penella, C., Nebauer, S.G., Quinones, A., Bautista, A. S., López-Galarza, S., and Calatayud, A. (2015). Some rootstocks improve pepper tolerance to mild salinity through ionic regulation. Plant Science 230:12–22.

[8] Yan, M. (2016). Hydro-priming increases seed germination and early seedling growth in two cultivars of Napa cabbage grown under salt stress The Journal of Horticultural Science and Biotechnology, 91, (4) 421-426.

[9] Shukla, N., Kuntal, H., Shanker, A., and Sharma, S. (2018). Hydro-priming methods for initiation of metabolic process and synchronization of germination in mung bean (Vigna radiata L.) seeds. Journal of Crop Science and Biotechnology, 21(2), 137-146.

[10] Taylor, A. G., and Harman, G. E. (1990). Concepts and Technologies of Selected Seed Treatments. Annual Review of Phytopathology, 28, 321-339.

[11] Parera, C. A., and Cantliffe, D. J. (1994). Presowing seed priming Horticultural Reviews, 16, 109-139.

[12] Sung, J. M., and Chiu, K. Y. (1995). Hydration effect on seedling emergence strength of watermelon seeds differing in ploidy. Plant Science, 110, 21-26.

[13] ISTA. (2019). International Rules for Seed Testing, International Seed Testing Association Bassersdorf, Switzerland.

[14] Ibrahim, E. A. (2016). Seed priming to alleviate salinity stress in germinating seeds. Journal of Plant Physiology, 192, 38-46.

[15] Ermis, S., Ozden, E., Njie, E. S., and Demir, I. (2016). Pre-treatment germination percentages affected the advantage of priming treatment in pepper seeds. American Journal of Experimental Agriculture, 13(1), 1-7.

[16] Taylor, A. G., Allen, P. S., Bennett, M. A., and Bradford, K. J. (1998). Seed enhancement. Seed Science Research, 8, 245-256.

[17] Demir, I., Ermis, S., Mavi, K., and Matthews, S. (2008). Mean germination time of pepper seed lots (Capsicum annuum L.) predicts size and uniformity of seedlings in germination tests and transplant modules. Seed Science and Technology, 36, 21-30.

[18] Taylor, A. G., and Ten Broeck. C. W. (1988). Seedling emergence forces of vegetable crops. HortScience, 23:367.

[19] Eneas Filho, J., Oliveira Neto, O. B., Prisco, J. T., Gomes Filho, E., and Monteiro, C. (1995). Effects of salinity in vivo and in vitro on cotyledonary galactosidases from Vigna unguiculata (L.) Walp. during seed germination and seedling establishment. Revista Brasilieria de Fisiologia Vegetal, 7 (2), 135-142.

[20] Maiti, R., Pramanik, K., (2013). Vegetable seed priming: a low cost, simple and powerful techniques for farmers' livelihood. Int. J. Bio-Resour. Stress Manag, 4, 475-481.