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Effects of pre-sowing soaking, chilling and heating treatments on germination of tomato (*Lycopersicon esculentum* Mill.) seeds

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Abstract

Growth period of tomato is dependent on cultivar, germination percentage, seedling establishment and temperature during growth. Drought, high and low temperatures have direct impact on plant. Soaking and temperature pre-treatments have a physiological and biochemical effect on seeds and improve their germination. In the present experiment, all the treatments (soaking, chilling and heating) increased the percentage and rate of germination. In both cultivars, seed soaking along with chilling led to increased germination percentage. The highest radicle and plumule length were obtained in the treatment combination of soaking and heating as well as that of soaking, heating and chilling. The highest plantlet dry weight obtained from soaking and heating treatment. In conclusion, soaking treatments along with thermal factor led to the improvement of germination-related traits and increased plantlet production.

Keywords: tomato; germination; chilling; heating; soaking

INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill.) is adapted to a wide range of climatic and soil conditions and as a warm season crop requires a relatively long seasons (Arin and Kiyak, 2003). Tomato is one of the most important vegetable crops in Iran and in the whole world. Tomato seed germination, like all other plants, is known to be a complex phenomenon that is affected by interactions between genetic determinants and environmental factors. To ensure a high germination, some treatments such as temperature, light, pre-soaking and seed coat scarification have been applied in various plant (Soyler and Khawar, 2007; Cirak et al., 2007, Esen et al., 2007). Soaking the seeds in water can be performed with or without aeration. Because of unlimited water availability, seeds eventually germinate, assuming that seeds are viable, not dormant, oxygen is available and a suitable temperature is employed (Farooq et al., 2006). Pre-sowing seed soaking of some wheat and rice cultivars increased grain yield compared with that of untreated seeds (Khahlon et al., 1992; Ella et al., 2011). Dry heat-treatment of seeds is used to control external and internal seed-borne pathogens such as fungi and bacteria (Akman, 2009) and to break seed dormancy (Oboho and Ogana, 2012). However, it should be considered that the high temperatures can reduce seed viability and seedling vigor (Lee et al., 2002; Basra et al., 2004a). The degree of promotion of seed germination by dry heat treatments showed a wide intra-specific variation (Herranz et al., 1998). Chilling treatments are used with various methods for shortening the emergence time and to protect seeds from abiotic and biotic stresses during the critical phase of seedling establishment (Basra et al., 2002). High- and low-temperature pre-sowing treatments have also been found effective for limiting secondary dormancy, decreasing abiotic and biotic stresses, enhancing the vigor and increasing performance in some species (Farooq et al, 2006; Jahangir et al., 2009). The aim of this study was to evaluate the effects of soaking and temperature pre-treatments on the improvement of germination and seedling performance of tomato seeds.

MATERIAL AND METHODS

Two tomato cultivars ('Super strain B.OP', 'Petoearly 84') were received from Hamilton Seed Company (Ontario, Canada).

Seed treatments: The seeds were surface sterilized with 5% NaClO (Sodium hypochlorite) for 5 min to avoid fungal infection, followed by washing with distilled water. The seeds of two cultivars were soaked in distilled water. Aeration was provided through shaking at 20˚C temperature for 24 h. For dry heat treatment, 250 g seeds of each cultivar were incubated at 40˚C for 24 h in an oven. For chilling treatment, 250 g seeds of each cultivar were incubated in polythene bags and placed in refrigerator at -19±2˚C for 24 h.

The study consisted of the following treatments: S - Soaking; S+C - Soaking followed by chilling; S+H - Soaking followed by heating; S+C+H - Soaking followed by chilling and heating; S+H+C - Soaking followed by heating and chilling; Cultured seeds incubated under constant 18±2˚C.

Germination test: Seeds were sown in petri dishes between layers of moisturized filter papers at 22˚C in an incubator. Germination was observed daily according to the Association of Official Seed Analysts method (AOSA, 1990).

Mean germination time (MGT) was calculated according to the equation of Ellis and Roberts (1981):

$MGT = \Sigma Dn / \Sigma n$, where n is the number of seeds germinated on the day D, and D is the number of days counted from the beginning of the germination assay.

Germination index (GI) was calculated as described in the AOSA (1983) via the following formula:

GI = the number of germinated seeds/days of first count + … + the number of germinated seeds/days of final count.

The ANOVA analysis of data was carried out by SPSS 15 (SPSS Inc., Chicago, Ill) and MSTATC software. Duncan's multiple range test was employed for mean comparison at 5% level.

RESULTS

All treatments of 'Super strain B.OP' and 'Petoearly 84' tomato cultivars increased the time needed for germination to begin which was five days in both cultivars. Similar results were observed for MGT which was shorter in the treated seeds than that in control (Table 1). All treated seeds had higher germination percentage and higher germination index (GI) compared with control. Seed treatments did not affect radicle length significantly (Table 1).

A significant increase in plumule length was noted in seeds subjected to S+H+C. In 'Super strain B.OP' and 'Petoearly 84' tomato cultivars, the seeds subjected to soaking and chilling (S+C) showed the earliest germination. A statistically significant increase in radicle and plumule length was observed in the seeds subjected to S+H and S+H+C, respectively.

The highest fresh weights in 'Super strain B.OP' and 'Petoearly 84' cultivars were resulted from S+C and S+C+H treatments. S+H treatment had the highest dry weight in both cultivars.

DISCUSSION

Pre-sowing soaking, heating and chilling treatments were successful for vigor enhancement in both 'Super strain B.OP' and 'Petoearly 84' tomato cultivars. These treatments enhanced synergistically the germination and emergence quality (Table 1). However, the most positive effect was due to soaking and chilling (S+C) followed by soaking, heating and chilling (S+H+C) (Table 1). Temperature, presoaking treatment has been shown to improve the germination percentages in caper seeds (Olmez et al., 2006), lettuce (Lewak and Khan, 1977; Soares et al., 2012), maize (Rahman et al., 2011) and spinach (Leskowar et al., 1999).

In both tomato cultivars vigor enhancements by dry heat treatment and chilling had also been reported earlier (Arin and Kiyak, 2003). In other studies, seed vigor was synergistically increased with osmo-conditioning of rice seeds (Basra et al., 2004b; Farooq et al., 2005).

Table 1. The effects of pre-sowing treatments on seed germination in 'Super strain B.OP' and 'Petoearly 84' tomato cultivars

Treatments	Percentage germination (%)	MGT (days)	GI	Radicle length (cm)	Plumule length (cm)	Fresh weight (g)	Dry weight (g)
			'Super strain B.OP'				
Control	60^{c}	4.35^{a}	51.32^{d}	4.14	4.17^{c}	0.10^{c}	0.0034c
S+C	76b^{c}	3.10^{c}	65.33^{c}	4.20	4.23^{c}	0.12^{a}	0.005a
S+H	80^{b}	3.43^{b}	69.11^{b}	4.46	4.99^{b}	0.10^{c}	0.0041^{b}
S+C+H	88^{a}	3.20^{c}	85.16^{a}	4.31	4.43^{c}	0.12^{a}	0.0035^{c}
S+H+C	80^{b}	3.23^{c}	70.65^{b}	4.66	5.33^{a}	0.11^{b}	0.0039^{bc}
Significance	**	**	**	ns	*	*	**
			'Petoearly 84'				
Control	52^{c}	4.81^{a}	49.73^{c}	7.99	4.83^{b}	0.13^{c}	0.0048^{b}
S+C	60^{b}	3.81^{d}	60.33^{b}	8.01	4.23^{c}	0.15^{ab}	0.0055^{a}
S+H	40^{d}	4.65^{b}	33.26^{d}	8.18	5.23^{a}	0.14^{b}	0.0043^{c}
S+C+H	66^{a}	3.83^{d}	64.33^{a}	7.83	4.31^{c}	0.16^{a}	0.0046^{c}
S+H+C	48^{cd}	4.23^{c}	47.17^{c}	8.11	5.22^{a}	0.13^{c}	0.0037^{d}
Significance	**	**	**	n.s.	*	*	**

S+C - Soaking followed by chilling; S+H - Soaking followed by heating; S+C+H - Soaking followed by heating after chilling; S+H+C - Soaking followed by chilling after heating; MGT - Mean germination time; GI - Germination index;
** Significant at $p \leq 0.01$; * Significant at $p \leq 0.05$; ns - Non-significant.

In conclusion, the sequential soaking, heating and chilling treatments can be employed for positively influencing the germination-related traits in both tomato cultivars.

REFERENCES

Akman, Z. (2009). Comparison of high temperature tolerance in maize, rice and sorghum seeds by plant growth regulators. *Journal of Animal and Veterinary Advances*, *8*(2), 358-361.

AOSA (1983). Seed vigor testing handbook. Contribution No. 32 to the handbook on seed testing. Association of Official Seed Analysis, Springfield, IL.

AOSA (1990). Rules for testing seeds. *Journal of Seed Technology*, 12,1-112.

Arin, L., & Kiyak, Y. (2003). The effects of pre-sowing treatments on emergence and seedling growth of tomato seed (Lycopersicon esculentum Mill.) under several stress conditions. *Pakistan Journal of Biological Sciences*, *6*(11), 990-994.

Basra, S. M. A., Zia, M. N., Mehmood, T., Afzal, I., & Khaliq, A. (2002). Comparison of different invigoration techniques in wheat (Triticum aestivum L.) seeds. *Pakistan Journal of Arid Agriculture (Pakistan)*, 39(2), 11-16.

Basra, S. M. A., Ashraf, M., Iqbal, N., Khaliq, A., & Ahmad, R. (2004a). Physiological and biochemical aspects of pre-sowing heat stress on cotton seed. *Seed Science and Technology*, *32*(3), 765-774.

Basra, S. M. A., Hafeez, K., Farooq, M., & Ahmad, N. (2004b). Osmohardening: A new technique for rice seed invigoration. *International Rice Research Notes*, *29*(2), 74-75.

Çırak, C., Kevseroğlu, K., & Ayan, A. K. (2007). Breaking of seed dormancy in a Turkish endemic Hypericum species: Hypericum aviculariifolium subsp. depilatum var. depilatum by light and some pre-soaking treatments. *Journal of Arid Environments*, *68*(1), 159-164.

Ellis, R. H., & Roberts, E. H. (1981). The quantification of ageing and survival in orthodox seeds. *Seed Science and Technology*, 9, 373-409.

Esen, D., Yildiz, O., Sarginci, M., & Isik, K. (2007). Effects of different pretreatments on germination of Prunus serotina seed sources. *Journal of Environmental Biology*, *28*(1), 99-104.

Ella, E. S., Dionisio-Sese, M. L., & Ismail, A. M. (2011). Seed pre-treatment in rice reduces damage, enhances carbohydrate mobilization and improves emergence and seedling establishment under flooded conditions. *AoB Plants*, *2011*, plr007.

Farooq, M., Basra, S. M. A., Ahmad, N., & Hafeez, K. (2005). Thermal hardening: a new seed vigor enhancement tool in rice. *Journal of Integrative Plant Biology*, *47*(2), 187-193.

Farooq, M., Basra, S. M. A., Cheema, M. A., & Afzal, I. (2006). Integration of pre-sowing soaking, chilling and heating treatments for vigour enhancement in rice (Oryza sativa L.). *Seed Science and Technology*, *34*(2), 499-506.

Herranz, J. M., Ferrandis, P., & Martínez-Sánchez, J. J. (1998). Influence of heat on seed germination of seven Mediterranean Leguminosae species. *Plant Ecology*, *136*(1), 95-103.

Jahangir, M., Kim, H. K., Choi, Y. H., & Verpoorte, R. (2009). Health-Affecting Compounds in Brassicaceae. *Comprehensive Reviews in Food Science and Food Safety*, *8*(2), 31-43.

Kahlon, P. S., Dhaliwal, H. S., Sharma, S. K., & Randhawa, A. S. (1992). Effect of pre-sowing seed soaking on yield of wheat (Triticum aestivum) under late sown irrigated conditions. *Indian Journal of Agricultural Sciences*, *62*(4), 276-277.

Lee, S. Y., Lee, J. H., & Kwon, T. O. (2002). Varietal differences in seed germination and seedling vigor of Korean rice varieties following dry heat treatment. *Seed Science and Technology*, *30*(2), 311-321.

Leskovar, D. I., Esensee, V., & Belefant-Miller, H. (1999). Pericarp, leachate, and carbohydrate involvement in thermoinhibition of germinating spinach seeds. *Journal of the American Society for Horticultural Science*, *124*(3), 301-306.

Lewak, S., & Khan, A. A. (1977). Mode of action of gibberellic acid and light on lettuce seed germination. *Plant Physiology*, *60*(4), 575-577.

Oboho, E. G., & Ogana, F. N. (2012). Effects of varying hot water temperatures on the germination and early growth of Dialuim guineense (Willd) seeds. *Annals of Biological Research*, *3*(3), 1247-1254.

Olmez, Z., Gokturk, A., & Gulcu, S. (2006). Effects of cold stratification on germination rate and percentage of caper (Capparis ovata Desf.) seeds. *Journal of Environmental Biology*, *27*(4), 667-670.

Rahman, M. M., Ahammad, K. U., & Alam, M. M. (2011). Effect of soaking condition and temperature on imbibition rate of maize and chickpea seeds. *Research Journal of Seed Science*, *4*(2), 117-124.

Soares, M. B. B., Galli, J. A., Trani, P. E. & Matins, A. L. M. (2012). Efeito da pré-embebição de sementes de alface em solução bioestimulante /Effect of pre-soaking seeds in biostimulant solution on germination and vigor of Lactuca sativa L./. *Biotemas* (Brasil), *25*(2), 17-23 (Español).

Soyler, D., & Khawar, K. M. (2007). Seed germination of caper (Capparis ovata var. herbacea) using α naphthalene acetic acid and gibberellic acid. *International Journal of Agriculture & Biology*, *9*(1), 35-37.