Journal of Stress Physiology & Biochemistry, Vol. 8 No. 3 2012, pp. 30-36 ISSN 1997-0838

ORIGINAL ARTICLE

Effect of NaCl priming duration and concentration on germination behavior of Tunisian safflower

Elouaer Mohamed Aymen,* and Hannachi Cherif

Department of Horticultural sciences, High Institute of Agronomy, Chott-Mariem, 4042, Tunisia

* *E-mail:* ***aymenouaer@gmail.com***

Received April 11 2012

Priming is an effective technique that improves germination of several crop species. That's why; this study was carried in order to evaluate the effect of NaCl seed priming techniques on germination and early growth of safflower (*Carthamus tinctorius* L.). Safflower seeds were primed with four concentrations of NaCl as priming media (5, 10, 15 and 20 g/l) for 12, 24 and 36 hours. Results indicated that different priming concentrations and duration have significant on total germination percentage, mean germination time, germination index and coefficient of velocity of safflower seeds. It was also observed that 12 h priming duration had the most effect on studied traits as 5 g/l priming concentration treatment. In general, primed seeds showed better performance than control (non primed seeds) in all studied parameters.

Key words: Germination, NaCl priming, priming concentration, priming duration, safflower seeds

ORIGINAL ARTICLE

Effect of NaCl priming duration and concentration on germination behavior of Tunisian safflower

Elouaer Mohamed Aymen,* and Hannachi Cherif

Department of Horticultural sciences, High Institute of Agronomy, Chott-Mariem, 4042, Tunisia

* *E-mail:* ***aymenouaer@gmail.com***

Received April 11 2012

Priming is an effective technique that improves germination of several crop species. That's why; this study was carried in order to evaluate the effect of NaCl seed priming techniques on germination and early growth of safflower (*Carthamus tinctorius* L.). Safflower seeds were primed with four concentrations of NaCl as priming media (5, 10, 15 and 20 g/l) for 12, 24 and 36 hours. Results indicated that different priming concentrations and duration have significant on total germination percentage, mean germination time, germination index and coefficient of velocity of safflower seeds. It was also observed that 12 h priming duration had the most effect on studied traits as 5 g/l priming concentration treatment. In general, primed seeds showed better performance than control (non primed seeds) in all studied parameters.

Key words: Germination, NaCl priming, priming concentration, priming duration, safflower seeds

Rapid and uniform field emergence is essential to achieve high yield with good quality and quantity in annual crops (Parera and cantliffe, 1994; Subedi and Ma, 2005; Yari *et al*., 2010). In this context, many research studies have demonstrated that seed priming is an effective technology to enhance rapid and uniform emergence, and to achieve high vigor and better yields in vegetables (Parera and Cantliffe, 1994; Bruggink *et al*., 1999) and field crops (Chiu *et al*., 2002; Giri and Schillinger 2003; Basra *et al*., 2005; Kaur *et al*., 2005; Farooq *et al*., 2006). In fact, this technique is a treatment that is applied to seeds before germination in a specific environment. Seeds are partially hydrated to a point where germination processes begin but radical emergence does not occur (Dell Aquila and Tritto, 1991; Giri and Schilinger, 2003; Kaur, 2002). It allows some of the metabolic processes necessary for germination to occur without germination take place. Seeds are soaked in different solutions with high osmotic potential; this prevents the seeds from absorbing enough water for radicle protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998). This method is used for improvement of germination speed, germination vigor, seedling establishment and yield (Talebian *et al*., 2008). In addition to better establishment,

farmers reported that primed crops grew more vigorously, flowered earlier and yielded higher (Farooq *et al.*, 2008).

Improvement in priming is affected by some factors such as plant species, priming media type and concentration, priming duration, temperature, vigor and seed primed storage condition (Mubshar *et al*., 2006). Consequently, priming formula differed according to vegetables species type and priming media used. In fact, Misra and Dwibedi (1980) have founded that seed soaking in 2.5% potassium chloride (KCl) for 12 h before sowing increased wheat yield by 15%. Paul and Choudhury (1991) also observed that seed soaking with 0.5 to 1% solution of KCl or potassium sulfate (K_2SO_4) significantly increased plant height and grain yield in wheat. According to Basra *et al*. (1989) priming of corn seed using polyethylene glycol or potassium salt (K_2HPO_4 or KNO_3) resulted in accelerated germination. So, the objective of this study was to evaluate the effect of NaCl seed priming at different concentration and duration on safflower germination behavior.

MATERIALS AND METHODS

The study was conducted in the laboratory of the Department of Agronomy and crop science of the High Institute of Agriculture Chott Mariem, Tunisia to determine seed priming effects on germination, and seedling growth of a Tunisian safflower cultivar.

Safflower seeds were fully immersed in priming media at 23 °C for 12, 24, and 36 h at four concentration (5, 10, 15 and 20 g/l) of NaCl priming media. All seeds were removed from priming media at the same time and then rinsed thoroughly with distilled water and hand dried lightly using blotting paper and then allowed to dry for 24 h at room temperature. Unsoaked seed (control) and primed seeds at different concentrations and duration were put to germinate in 90-mm-diameter Petri dishes on whatman No.2 filter paper moistened with 10 ml of distilled water. Twenty seeds from each of the treatments were placed in Petri dishes. The experiment was arranged factorial in a completely randomized design with three factors which are priming media (NaCl, KCl and untreated seed (control)), priming concentration (5, 10, 15 and 20 g/l) and priming duration (12, 24 and 36 h) in a completely randomized design with five replications and 20 seeds per replicate. Seeds were kept at room temperature (23°C) under normal light. Seeds were considered germinated when radicle protruded for 2 mm. Germination progress was measured at 24 h intervals and continued until fixed state at the 7^{th} day. Parameters measured in this experiment are given below.

Total germination (TG) measured in the seventh day using the formula GT (%) = (total number of germinated seeds/ total seed) x 100.

Mean germination time (MGT) calculated according the formula of Ellis and Roberts, (1981). MGT = ∑ (ni/di). With ni: number of germinated seeds and di: day of counting.

Germination Index (GI) according to the equation of Kader and Jutzi, (2004): GI = ∑ (TiNi). Ti: number of day after sowing and Ni: number of germinated seeds in the th day.

Coefficient of velocity (CV) = (number of germinated seeds per day) according to Kader and Jutzi formula, 2004. CV= ($\sum N_i /100$) x ($\sum T_i N_i$).

All the data were subjected to an analysis of variance, using SPSS 13.0 software and the difference between means were compared by

Duncan multiple range test at 5% level of probability.

RESULTS

According to the results, all studied traits were affected by the experimental factors and there was completely significant difference between control (non primed seeds) and primed seeds (Table 1-2). Total germination percentage (TGP) was affected by NaCl concentration as well it was decreasing (91%) by increased of NaCl concentration from 5 to 20 g/l. Also TGP was decreased (90.22%) by increasing of NaCl priming duration from 12 h to 36 h. Mean comparison by Duncan multiple range tests displayed significant difference between control and NaCl primed seeds as well more TGP was attained in NaCl primed seed than control in all concentrations (Table-2). Variance analysis and mean comparison results displayed that mean germination time (MGT) was affected by different priming concentration and seed priming duration. The least MGT was obtained from 5 g/l priming concentration (3.84) and 12 h NaCl priming duration (3.48) treatments. Generally less MGT was attained from NaCl seed priming treatment than control (Tables 2). It supports that NaCl seed priming caused more rapid water uptake than the amount of water for germination. Variance analysis and mean comparison results displayed that germination index was affected by different priming concentration and seed priming duration. The highest germination index was attained for 12 h priming duration and 5 g/l concentration of priming (58.18 and 52.70 respectively). Meanwhile, germination index decreased by priming concentration and duration increment. Generally, NaCl priming treatments, especially with 5 g/l at 12 h, significantly increased total germination percentage, germination index and coefficient of velocity and decreased mean germination time of safflower seeds compared to non-priming.

Table 1. Variance analysis of germination behavior of safflower with NaCl priming

Source of Variation	df	Total Germination	MGT	GI	CV
Duration (D)	2	6068.517*	15.413*	2463.347*	96.074*
Concentration (C)	3	1450.218*	3.331*	580.188*	22.650*
D x C	6	213.741*	0.098*	66.662*	2.397*
Error	24	1.158*	0.004*	0.603*	0.025*
Total	36				

(*) Significant at the 5% levels of probability according to Duncan test

Table 2. Means comparison of studied traits in safflower by Duncan multiple range test.

	Total germination (%)	**Mean Germination Time (days)**	**Germination Index**	**Coefficient of velocity**
Duration (hour)				
12	81.62[a]	3.48[c]	58.18[a]	9.36[a]
24	54.96[b]	4.49[b]	42.73[b]	6.31[b]
36	36.92[c]	5.74[a]	29.55[c]	3.70[c]
Control (dry seed)	73.61	6.23	42.12	6.79
Concentration (g/l)				
5	71.73[a]	3.84[d]	52.70[a]	8.40[a]
10	64.46[b]	4.33[c]	47.14[b]	7.02[b]
15	51.81[c]	4.90[b]	39.56[c]	5.62[c]
20	43.34[d]	5.21[a]	34.55[d]	4.79[d]
Control (dry seed)	73.61	6.23	42.12	6.79

(*) Means with the same letters in each column are not significantly different at 0.05 according to Duncan test

DISCUSSION

According to emergence uniformity problem and importance of safflower in Tunisia, it is necessary to improve germination and growth in this species. Basra *et al*. (2003) reported improvement in germination percent by using seed priming techniques. In fact priming induces a range of biochemical changes in the seed that required initiating the germination process i.e., breaking of dormancy, hydrolysis or metabolism of inhibitors, imbibitions and enzymes activation (Ajouri *et al.,* 2004). Some previous researcher indicated that some or all process that precede the germination are triggered by priming and persist following the re-desiccation of the seed (Asgedom and Becker, 2001). Thus upon sowing, primed seed can rapidly imbibe and revive the seed metabolism, resulting in higher germination percentage and a reduction in the inherent physiological heterogeneity in germination (Rowse, 1995). Sung and Chiu (1995) observed that MGT was accelerated by hydropriming without changing amount of water uptake in watermelon. The probable reason for early germination of primed seed maybe due to the completion of pre-germination metabolic activities making the seed ready for radicle protrusion and the primed seed germinated soon after planting compared with untreated dry seed (Arif, 2005). Primed seeds had lower mean germination time (MET) compared with un-primed seeds. These positive effects are probably due to the stimulatory effects of priming on the early stages of germination process by mediation of cell division in germinating seeds (Sivritepe *et al*., 2003). Ruan et al. (2002) has demonstrated that KCl and $CaCl_2$ seed priming had improved germination index of rice. The efficiency of seed priming is possibly related to the osmotic advantage that K^+ and Ca^{2+} have in improving cell water saturation, and that they act as co-factors in the activities of numerous enzymes (Taiz and Zeiger 2002). Demir Kaya *et al*. (2006) have reported that NaCl seed priming treatments was the most effective method for improving seed germination of sunflower. These results are in line with findings of Sivritepe *et al*. (1999) in melon and Khan *et al*. (2009) in hot pepper. Improving germination and coefficient of velocity in safflower seeds after NaCl priming may be explained by an increased rate of cell division in the seeds (Bose and Mishra, 1992). It is concluded that priming media concentration and soaking time have significant effects on germination; when those parameters (priming concentrations and duration) increased, total germination decreased, this could be due to the toxic effects of Na^+ and Cl^- on germination process (Khajeh-Hosseini *et al*., 2003). Primed seeds compared to non-primed seeds were allowed to imbibe water and went through the first stage of germination without protrusion of radicle. Better results of of NaCl priming (5 g/l for 12 h) treatment could be due to the uptake of Na^+ and Cl^- ions by the seed, maintaining a water potential gradient allowing water during seed germination (Demir Kaya *et al*., 2006).

This study showed that NaCl seed priming especially with 5 g/l at 12 h could be used to increase germination percentage, shortened mean germination time. Further studies needed to investigate the effects of priming on later growth and development stages of this species. Overall, it could be concluded that the suitable priming conditions, which resulted in higher germination percentage and seedling growth for safflower seeds is, 12 h duration at 5 g/l NaCl priming concentration at the temperature of 23°C. This information can be employed by safflower growers for improving the

performance of crop in the field under adverse abiotic conditions.

REFERENCES

Ajouri, A., Haben, A., and Becker, M. (2004) Seed priming enhances germination and seedling growth of barley under conditions of P and Zn deficiency. *J. Plant Nut. Soil Sci*. **167,** 630-636.

Arif, M. (2005) Seed priming improves emergence, yield and storability of soybean. PhD thesis in Agronomy. NWFP Agricultural University Peshawar, Pakistan.

Asgedom, H., and Becker, M. (2001) Effects of seed priming with nutrient solutions on germination, seedling growth and weed competitiveness of cereals in Eritrea. In: Proc. Deutscher Tropentag, University of Bonn and ATSAF, Magrraf Publishers Press, Weickersheim, 282 p.

Basra, A.S., Dhillon, R., and Malik, C.P. (1989) Influence of seed pretreatment with plant growth regulators on metabolic alterations of germinating maize embryos under stressing temperature regimes. *Ann. Bot. (London)*. **64,** 37-41.

Basra, S.M.A., Zia, M.N., Mehmood, T., Afzal, I., and Khaliq, A. (2003) Comparison of different invigoration techniques in wheat (*Triticum aestivum*) seeds. *Pak. J. Arid Agric*. **5,** 6-11.

Basra, S.M.A., Farooq, M. and Tabassum, R. (2005) Physiological and biochemical aspects of seed vigor enhancement treatments in fine rice (*oryza sativa* L.). *Seed Sci. and Technol*. **33,** 623-628.

Bose, B. and Mishra, T. (1992) Response of wheat seed to presowing seed treatment with Mg (N03h. *Ann. Agric. Res*. **13,** 132-136.

Bruggink G. T., Ooms J. J. J. and Van der Toorn P. (1999) Induction of longevity in primed seeds. *Seed Sci. Res*. **9,** 49-53.

Chiu, K.Y., Chen C.L., and Sung J.M. (2002) Effect of priming temperature on storability of primed sh-2sweet corn seed . *Crop Sci*. **42,** 1996-2003.

Dell Aquila, A., and Tritto, V. (1991) Germination and biochemical activities in wheat seeds following delayed harvesting, ageing and osmotic priming. *Seed Sci. and Technol*. **19,** 73-82.

Demir Kaya, M., Okçu, G., Atak, M., Çikili, Y. and Kolsarici, Ö. (2006) Seed treatment to overcome salt and drought stress during germination in sunflower (*Helianthus annuus* L.). *Eur. J. Agronomy*. **24,** 291-295.

Farooq, M., Basra, S.M.A., and Hafeez, R. (2006) Seed priming enhances emergence, yield and quality of direct-seeded rice. *Crop management and physiology*. 42- 44.

Farooq, M., Basra, S.M.A., Hafeez, R., and Saleem B.A. (2008) Seed priming enhances the performance of late sown wheat (*Triticum aestivum*L.) by improving chilling tolerance. *J. of Agr. and Crop Sci*. **194** (1), 55-60.

Giri, G.S., and Schilinger, W.F. (2003) Seed priming winter wheat for germination, emergence and yield. *Crop Sci*. **43,** 2135-2141.

Kaur, S., Gupta, A.K. and Kaur, N. (2005) Seed priming increases crop yield possibly by modulating enzymes of sucrose metabolism in chickpea. *J. Agron. and Crop Sci*. **191,** 81-87.

Khaje-hosseini, M., Powell, A.A., Bingham, I.J. (2003) The interaction between salinity stress and seed vigour during germination of soybean seeds. *Seed Sci. Technol*., **31,** 715–725.

Khan, M.A., Ansari, R., Ali, H., Gul, B. and Nielsen, B.L. (2009) Panicum turgidum: a sustainable

feed alternative for cattle in saline areas. *Agric. Ecosys. Environ*., **129,** 542-546.

Lianes, A., Reinoso H., and Luna, V. (2005) *World J. of Agricultural Sciences* **1(2)**, 120-128.

Mubshar, H., Farooq M., Basra, S.M.A. and Ahmad, N. (2006) Influence of seed priming techniques on the seedling establishment, yield and quality of hybrid Sunflower. *Int. J. Agri. Biol.* **8(1)**, 14-18.

Parera, C.A., and Cantliffe D.J. (1994) Pre-sowing seed priming. *Hortic. Rev*. **16,** 109-141.

Paul, S.R., and Choudhury, A.K. (1991) Effects of seed priming with potassium salts on growth and yield of wheat under rain fed condition. *Ann. Agric. Res*. **12,** 415-418.

Rowse, H.R. (1995). Drum Priming- A non-osmotic method of priming seeds. *Seed Sci. and Technol*. **24,** 281-294.

Ruan, S., Xue, Q., Tylkowska, K. (2002) The influence of priming on germination of rice Oryza sativa L. seeds and seedling emergence and performance in flooded soil. *Seed Sci. Technol.* **30,** 61-67.

Sivritepe, H.O., Eris, A., Sivritepe, N. (1999) The effects of priming treatments in melon seeds. *Acta Hort*., **492,** 287–295.

Sivritepe, N., Sivritepe H.O., and Eris, A. (2003) The effects of NaCl priming on salt tolerance in melon seedling grown under saline conditions. *Scientia Holti*. **97,** 229-237.

Subedi, K.D., and Ma, B.L. (2005) Seed priming does not improve corn yield in a humid temperate environment. *Agron. J*. **97,** 211-218.

Sung, J.M., Chiu, K.Y. (1995) Hydration effects on seedling emergence strength of watermelon seed differing in ploidy. *Plant Sci*. **110,** 21–26.

Taiz, L., Zeiger, E. (2002) Plant Physiology. 3rd edn. Sinaure Associates, Inc. Publishers, Su and Land, Massachusetts.

Talebian, M.A., Sharifzadeh, F., Jahansouz, M.R., Ahmadi, A., and Naghavi, M.R. (2008) Evaluation the effect of seed priming on germination, seedling stand and grain yield of wheat cultivars (*Triticum aestivum* L.) In three different regions in Iran. *Ir. J. Crop Sci*. **39**(1), 145-154.

Taylor, A.G., Allen, P.S., Bennett, M.A., Bradford, K.J., Burrisand, J.S. and Misra M.K. (1998) Seed enhancements. *Seed Sci. Res*. **8,** 245-256.

Yari, L., Aghaalikhani, M., Khazaei, F. (2010) Effect of Seed priming duration and temperature on seed germination behavior of bread wheat (*Triticum aestivum* L.). *ARPN Journal of Agricultural and Biological Science*. **5(1),** 5-8