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OSMOPRIMING IMPROVES THE GERMINATION AND EARLY SEEDLING GROWTH OF MELONS *(CUCUMIS MELO* L.)

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Melons germinate poorly under sub- and supra optimum temperatures. Seed priming has potential to improve the germination under wide range of conditions. A laboratory study was conducted to evaluate the possibility of improving germination and enhancing seedling growth by osmopriming in melon. Seeds were soaked in aerated 1, 2 and 3% solutions of KNO_3 and $CaCl_2$ for 24 h. Osmopriming in KNO_3 performed better than in $CaCl_2$. Osmopriming in KNO_3 solutions improved the germination rate and uniformity, and early seedling growth, being the best with its lowest concentration. None of the priming treatments improved seedling fresh weight, however, improvement in seedling dry weight was observed from seeds osmoprimed with 1% KNO_3 solution. Osmopriming in $CaCl_2$ solutions performed similar to even inferior than untreated seeds.
Keywords: Osmopriming, melons, emergence, seedling growth

INTRODUCTION

Melons *(Cucumis melo* L.) like other cucurbits, germinates poorly at low temperature (Nerson and Govers, 1986). Optimum seed germination and seedling emergence occur at relatively high temperatures (25–28 ◦C). Poor germination is a common phenomenon at sub-optimal temperatures is of great concern for growers who produce melon crops in late winter and early spring in the Pakistan. Delayed and reduced seedling emergence cause non-uniform plant development, thereby extending melon fruit maturation for early markets. Seed priming treatments using salts such as KNO_3 have been effective in improving watermelon germination at low temperatures (Demir and Van de Venter, 1999). Seed maturation stage can also be an influential factor in germination performance at low temperatures and response to priming treatment (Olouch and Welbaum, 1996). In general, mature seeds tend to show a better germination performance at stress temperatures than those of earlier and later harvests, while advancement obtained by priming was greater in earlier harvests (e.g. premature seeds). Priming can be a valuable process for improving germination and uniformity of heterogenously matured seed lots (Olouch and Welbaum, 1996). Seed priming has been successfully demonstrated to improve germination and emergence in seeds of many crops, particularly seeds of vegetables and small seeded grasses (Bradford, 1986). Osmopriming with KNO_3 has been reported to increase the embryo length in tetraploid watermelon seeds (Nerson *et al.,* 1985). In another study, Sung and Chiu (1995) found that primed watermelon seeds had higher seedling emergence force.

In a range of field crops including rice (Zheng *et al.*, 2002; Basra *et al.*, 2004; Farooq *et al.,* 2006), pansy (Yoon *et al.*, 1997), wheat (Nayyar *et al.*, 1995) and sunflower (Kathiresan *et al.,*1984) osmopriming in salts of calcium have been found very effective for improving germination rate and stand establishment.

Although, a lot of work has been done on the osmopriming of vegetable crops including melons, very little has been reported on the performance of melon seeds osmoprimed in salts of calcium and KNO_3. This study was, therefore, carried out with the objective to evaluate the performance of melon seeds osmoprimed in salts of calcium and KNO_3.

MATERIAL AND METHODS

Seed of melon cultivar Ravi obtained from Vegetable Research Institute, Ayyub Agricultural Research Institute; Faisalabad, Pakistan was used in the present study. The initial seed moisture contents were 8.63

% (on dry weight basis). The seeds were soaked in aerated 1, 2 and 3% solutions of each KNO_3 and $CaCl_2$ for 24 h. The ratio of seed weight to solution volume was 1:5 (g/mL) (Farooq *et al.,* 2006).

After priming, seeds were given three surface washings with distilled water and re-dried to original weight with forced air under shade at 27± 3 °C (Basra *et al.,* 2002). These seeds were then sealed in polythene bags and stored in refrigerator at 5°C before further use.

Control and treated seeds were sown in 5 kg plastic pots containing moist acid/water washed sand and placed in a net-house. The number of emerged seeds was recorded daily according to the seedling evaluation Handbook of Association of Official Seed Analysts (1990) until a constant count was achieved. Time taken to 50% emergence of seedlings (E_{50}) was calculated according to the following formulae of Coolbear *et al.* (1984) and modified by Farooq *et al.* (2005):

Where N is the final number of emerged seeds, and n_i and n_j the cumulative number of seeds emerged by adjacent counts at times t_i and t_j when $n_i < N/2 < n_j$.

Mean emergence time (MET) was calculated according to the equation of Ellis and Roberts (1981) as under:

Where n is the number of seeds, which were emerged on day D, and D is the number of days counted from the beginning of emergence.

Coefficient of uniformity of emergence (CUE) was calculated using the following formulae of Bewley and Black (1985):

Where t is the time in days, starting from day 0, the day of sowing, and n is the number of seeds completing emergence on day t and is equal to MET.

Emergence index (EI) was calculated as described in the Association of Official Seed Analysts (1983) as the following formulae:

Energy of emergence (EE) was recorded on the fourth day after plantation. The percentage of emerging seeds 4 d after plantation is relative to the total number of seeds tested (Ruan *et al.,* 2002). On the fifteen day after emergence, the seedlings were tested for vigor after carefully removing from the sand. Number of roots, shoot and root length of 5 randomly selected seedlings were recorded per replicate and averaged. Seedling fresh weight was determined immediately after harvest, whereas dry weight was taken after drying at 70^{o}C for 7 d.

RESULTS

Osmopriming with KNO_3 at all the three concentrations significantly reduced the time to start emergence and E_{50} compared with control (Table 1). Osmopriming with $CaCl_2$ did not decrease the start to emergence and E_{50} for the 2% solution (Table 1). All the osmopriming treatments reduced the MET (Table 1). Osmopriming with KNO_3 at all the three concentrations and 1% $CaCl_2$ resulted in improved emergence percentage and emergence energy compared with other treatments including untreated seeds. Osmopriming with 1% KNO_3 resulted in maximum emergence index, while, osmopriming with 2% $CaCl_2$ behaved similar to that of control. All other treatments resulted in lower EI than that of untreated seeds (Table 1). Osmopriming with 1% KNO_3 and 2% $CaCl_2$ resulted in improved CUE; all other treatments reduced the CUE compared with the control (Table 1).

Osmopriming with KNO_3 at all the three concentrations and with 3% $CaCl_2$ resulted in improved root length compared with untreated seeds but priming with 1% $CaCl_2$ reduced in root length (Table 2). With the exception of 2% $CaCl_2$ all the priming treatments increased the shoot length (Table 2). None of the treatments increased the seedling fresh weight and priming with $CaCl_2$ (at all the concentrations) lowered the seedling fresh weight (Table 2). However, osmopriming with 1% KNO_3 resulted in increased seedling dry weight (Table 2). Osmopriming with 1% KNO_3 increased the number of roots (Table 2).

DISCUSSION

The present study showed that osmopriming techniques can enhance the germination and early seedling growth in melons.

Osmopriming with KNO_3 and 1% $CaCl_2$ improved the emergence rate and early seedling growth. Osmopriming with KNO_3 not only resulted in earlier and more uniform emergence (as is clear from lower values of time to start emergence, E_{50} and MET) but the emergence percentage, energy of emergence and emergence index were also improved. Gray *et al.* (1984) concluded that osmopriming of a slowly germinating stock improved the percentage seedling emergence compared with untreated seeds. Priming also reduced the mean emergence time but had no effect on the spread of emergence time of parsnip seeds. Nerson and Govers (1986) subjected the seeds of muskmelon to salt priming and found that 2-3% solutions of KH_2PO_4 + KNO_3 (1:1) for 1-5 days significantly increased the emergence rate, synchronization and percentage.

Table 1. Influence of seed priming on the seedling establishment of melons

Treatments	Time to start emergence	E_{50} (days)	MET (days)	EE (%)	FEP (%)	EI
Control	3.5 a	4.06 a	5.87 b	62.23 b	86.67 b	8.91 c
Osmopriming with 1% KNO_3	2.5 c	3.25 d	3.75 e	92.67 a	96.67 a	11.54 a
Osmopriming with 2% KNO_3	3.0 b	3.74 b	4.49 d	66.67 b	73.33 d	3.96 g
Osmopriming with 3% KNO_3	3.0 b	3.52 c	4.46 d	90.00 a	96.67 a	6.61 e
Osmopriming with 1% $CaCl_2$	3.5 a	3.71 b	5.35 c	70.00 b	90.00 b	7.85 d
Osmopriming with 2% $CaCl_2$	3.5 a	4.10 a	6.10 a	46.67 c	86.67 b	9.59 b
Osmopriming with 3% $CaCl_2$	3.5 a	3.87 b	4.82 d	56.67 bc	83.33 bc	5.41 f

Table 2. Influence of seed priming on the seedling establishment of melons

Treatments	Root length (cm)	Shoot length (cm)	Seedling fresh weight (mg)	Seedling dry weight (mg)	CUE	No. of roots
Control	6.55 c	6.45 d	530 a	23.1 b	0.45 c	5.80 b
Osmopriming with 1% KNO_3	9.32 a	9.27 a	536 a	29.5 a	0.63 a	7.56 a
Osmopriming with 2% KNO_3	6.72 c	7.97b	525 a	22.6 b	0.22 e	6.00 b
Osmopriming with 3% KNO_3	7.34 b	7.45 bc	494 a	21.2 b	0.22 e	5.80 b
Osmopriming with 1% $CaCl_2$	5.6 d	7.05 c	408 b	17.4 bc	0.36 d	4.60 c
Osmopriming with 2% $CaCl_2$	6.23 c	6.38 d	299 d	15.3 bc	0.51 b	4.80 c
Osmopriming with 3% $CaCl_2$	7.53 b	8.20 b	373 c	19.5 b	0.27 e	4.80 c

The beneficial effect of priming with KNO_3 solution on melon emergence confirms previous findings on the germination of watermelon seeds at low temperatures in laboratory conditions (Nerson *et al.,* 1985; Demir and Van de Venter, 1999; Demir and Oztokat, 2003). Similar results have been also obtained with other species of the same family (Bradford, 1985). Osmopriming with KNO_3 and $CaCl_2$ (at low concentration) also improved the emergence percentage that might be due to overcoming some seed dormancy and /or improving embryonic development. Agreeing with that assumption, Nerson *et al.* (1985) reported that KNO_3 priming increased embryo length in tetraploid watermelon seeds. Seed hydration treatments may help to break the seed dormancy by softening seede coat and / or leaching of germination inhibitors (Joshi and Singh, 2004). Sung and Chiu (1995) also indicated that primed watermelon seeds had higher seedling emergence force. Priming might also be effective through softening the seed coat and ease of the mechanical restriction of coat (i.e. softening) which was reported to be one cause of emergence failure in melon seeds differing in ploidy (Sung and Chiu, 1995). This positive effect of priming was clearly reflected in subsequent root and shoot length and seedling dry weight agreeing with the observations of Sung and Chiu (1995) in watermelon seeds.

The interesting findings of this study are that osmopriming with low concentration of KNO_3 was more effective for improvement in germination and early seedling growth. Moreover, priming in $CaCl_2$ solutions was not effective which is in contrast with the earlier reports in rice (Farooq *et al.,* 2006), pansy seeds (Yoon *et al.*, 1997) and sunflower (Kathiresan *et al.,*1984). Osmopriming with high concentration of KNO_3 may have some toxic effects as reported by Basra *et al.*, (2003, 2005) and Farooq *et al.,* (2006a) in rice. From the present study, it may be concluded that the osmopriming in low concentration of KNO_3 is more effective for improvement in germination and early seedling growth, while priming in $CaCl_2$ solutions could not improve the performance rather it impaired the seedling emergence and growth.

LITERATURE CITED

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

Association of Official Seed Analysis (AOSA). 1990. Rules for testing seeds. *J. Seed Technol.,* 12**,** 1-112.

Basra, S.M.A., M. Farooq, K. Hafeez and N. Ahmad. 2004. Osmohardening: A new technique for rice seed invigoration. *Int. Rice Res. Notes,* 29, 80-81.

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

Basra, S.M.A., M.N. Zia, T. Mehmood, I. Afzal and A. Khaliq. 2002. Comparison of different invigoration techniques in wheat (*Triticum aestivum* L.) seeds. *Pak. J. Arid Agric.,* 5, 11-16.

Bewley, J.D. and M. Black. 1985. Seed Physiology of development and germination. Plenum Press. New York.

Bradford, K.J. 1986. Manipulation of seed water relations via osmotic priming to improve germination under stress conditions. *Hort. Sci.*, 21, 1105-1112.

Bradford, K.J. 1985. Seed priming improves germination and emergence of cantaloupe at low temperature. *Hort. Sci.*, 20, 596.

Coolbear, P., A. Francis and D. Grierson. 1984. The effect of low temperature pre-sowing treatment under the germination performance and membrane integrity of artificially aged tomato seeds. *J. Exp. Bot.*, 35**,** 1609-1617.

Demir, I. and C. Oztokat. 2003. Effect of salt priming on germination and seedling growth at low temperatures in watermelon seeds during development. *Seed Sci.. and Technol.*, 31, 765–770.

Demir, I. and H.A. Van deVenter. 1999. The effect of priming treatments on the performance of watermelon (*Citrullus lanatus* (Thunb.) Matsum and Nakai) seeds under temperature and osmotic stress. *Seed Sci. and Technol.,* 27, 871–875.

Dharmalingam, C. and R.N. Basu. 1990. Maintance of viability and vigour in sunflower. *Seed Sci. Res.*, 18, 15–24.

Edelstein, M. and J. Kigel. 1990. Seed germination of melon *(Cucumis melo)* at sub- and supra-optimal temperatures. *Scientia Hort.,* 45, 55-63.

Ellis, R.A. and E.H. Roberts. 1981. The quantification of ageing and survival in orthodox seeds. *Seed Sci. and Technol.*, 9, 373-409.

Farooq, M., S.M.A. Basra, K. Hafeez and N. Ahmad. 2005. Thermal hardening: a new seed vigor enhancement tool in rice. *J. Integr. Plant Biol.,* 47, 187-193.

Farooq, M., S.M.A. Basra and K. Hafeez. 2006. Rice seed invigoration by osmohardening. *Seed Sci. and Technol.*, 34, 181-187.

Farooq, M., S.M.A. Basra, R. Tabassum and N. Ahmed. 2006a. Evaluation of seed vigor enhancement techniques on physiological and biochemical basis in coarse rice. *Seed Sci. and Technol.,* 34, 741-750.

Gray, D., P.A. Brocklehurst, J.A. Steckel and J. Dearman. 1984. Priming and pregermination of parsnip (*Pastinaca sativa* L.) seed. *Hort. Sci.,* 59, 101-108.

Halmer, P. and J.D. Bewley. 1984. Aphysiological perspective on seed vigour testing. *Seed Sci. and Technol.,* 12, 561–575.

Heydecker, W. and P. Coolbear. 1977. Seed treatments for improved performance - survey and attempted prognosis. *Seed Sci. and Technol.*, 5, 353-425.

Kathiresan, K., V. Kalyani and J.L. Ganarethinam. 1984. Effect of seed treatments on field emergence, early growth and some physiological processes of sunflower (*Helianthus annuus* L.). *Field Crop Res.*, 9, 215-217.

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

Nayyar, H., D.P. Walia and B.L. Kaishta. 1995. Performance of bread wheat (*Triticum aestivum* L.) seeds primed with growth regulators and inorganic salts. *Indian J. Agric. Sci.*, 65, 112-116.

Nerson, H. and A. Govers. 1986. Salt priming of muskmelon seeds for low temperature germination. *Scientia Hort.,* 28, 85-91.

Nerson, H., H.S. Paris, Z. Karchi and M. Sachs. 1985. Seed treatments for improved germination of tetraploid watermelon. *Hort Sci.,* 15, 253–254.

Olouch, M.O. and G.E. Welbaum. 1996. Effect of postharvest washing and post-storage priming on viability and vigour of 6-year old muskmelon (*Cucumis melo* L.) seeds from eight stages of development. *Seed Sci. and Technol.*, 24, 195–209.

Parera, C.A. and D.J. Cantliffe. 1994. Pre-sowing seed priming. *Hort. Review*, 16, 109–141.

Rao, S.C., S.W. Aker and R.M. Ahring. 1987. Priming Brassica seed to improve emergence under different temperatures and soil moisture conditions. *Crop Sci.*, 27, 1050–1053.

Sachs, M. 1977. Priming watermelon seeds for low temperature germination*. J. American Society of Hort. Sci.*, 102, 175–178.
Sadeghian, S.Y. and N. Yavari. 2004. Effect of water-deficit stress on germination and early seedling growth in sugar beet. *J. Agron. and Crop Sci.,* 190, 138–144.
Singh, B.G. 1995. Effect of hydration-dehydration seed treatments on vigour and yield of sunflower. *Ind. J. of Plant Physiol.*, 38, 66–68.
Singh, B.G. and G. Rao. 1993. Effect of chemical soaking of sunflower (*Helianthus annuus* L.) seed on vigour index. *Ind. J. Agric. Sci.*, 63, 232–233.
Sung, J.M. and K.Y. Chiu. 1995. Hydration effect on seedling emergence strength of watermelon seeds differing in ploidy. *Plant Sci.*, 110, 21–26.
Yoon, B.Y.H., H.J. Lang and B.G. Cobb. 1997. Priming with slat solutions improves germination of pansy seed at high temperatures. *Hort. Sci.*, 32, 248-250.
Zheng, H.C., H.U. Jin, Z. Zhi, S.L. Ruan and W.J. Song, 2002. Effect of seed priming with mixed- salt solution on germination and physiological characteristics of seedling in rice (*Oryza sativa* L.) under stress conditions. *J. Zhejiang Univ, (Agric. and Life Sci.),* 28, 175-178.