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SEED PRIMING FOR IMPROVED SEEDLING VIGOUR IN CHILLIES

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Abstract

Chilli, a potential horticultural crop but a problematic one, problems starting from seed sowing up to marketing. Germination in chilli is prolonged and non-uniform, which affect crop stand establishment, particularly under stress condition like salinity that delays germination, emergence and seedling growth. This study was carried out to evaluate the effect of seed priming on salt tolerance in chilli during emergence and early seedling growth stages. Seeds of chilli cv. Hot Queen were primed in water (hydropriming) and NaCl (1% solution) (halopriming) and sown in pots at different salinity levels [1.17 (control), 3, 5 and 7 dS m^{-1}], along with unprimed seeds. Emergence rate, final emergence percentage (FEP), shoots length, seedling vigour and dry weight were positively affected by both priming treatments over the control; halopriming was more effective than hydropriming. Number of secondary roots was higher in haloprimed and unprimed seeds. Seed priming treatment did not significantly affect root length and fresh weight of seedlings. Results indicated that seed priming could be used for improving performance of chilli seeds and seedlings grown under saline conditions.

INTRODUCTION

Chilli (*Capsicum annum*) is cultivated on a large area (38.4 thousand hectares) in Pakistan for its fresh fruit as well as for spice production (Anonymous, 2006a). It is grown mainly in Sindh and southern Punjab as a summer crop. It is an excellent source of vitamin A, B, C, E and P (citrin) besides capsaicin. Capsaicin, the main constituent causing hotness, helps in digestion; dilates blood vessels and prevents heart diseases. Chilli production in Pakistan not only fulfils domestic demand but also helps in earning foreign exchange (Zia, 2006). Pakistan earned Rs. 1.127 billion during 2003-04 by exporting red chilli powder (Anonymous, 2006b) to Middle East, USA and other countries.

Acreage under chillies is increasing, particularly in Punjab due to a shift in production trend from cotton based farming to non-traditional crop production, which in turn is due to a decline in income from cotton crop. But the yield gap is too high; 1 to 2 tonnes ha^{-1} in Pakistan as compared to 20 tonnes in other chilli producing countries like China. One of the main reasons of this yield gap is high soil salinity in southern Punjab and Sindh; characteristics of arid climate.

Chilli is reported as a salt sensitive (Haman, 2000) to moderately salt sensitive (Kanber et al., 1992) crop and prefers soil having salinity less than 1920 ppm (Carter, 1994). Delayed and non-uniform germination and poor emergence are the characteristic problem in chillies. The problem is further aggravated if seed are sown under stress conditions (Demir and Okcu, 2004) i.e. low temperature or high salinity levels. Soil salinity is a major factor limiting chilli production by affecting crop plant establishment (Al-Karaki, 2001). Yield decreases by 14% with every unit increase in salinity above its threshold (1.7 dS m^{-1}) value (Rhoades et al., 1992).

Seed invigoration techniques have been employed to achieve improvements in the rate and uniformity of germination, root growth and seed vigour (Thornton and Powell, 1992) and tolerance to environmental stresses (Heydecker, 1972) in a number of crops. Fresh seeds of different tomato cultivars primed in PEG-8000, NaCl and KNO_3 produced more vigorous seedlings than untreated seeds (Farooq et al., 2005). Sivritepe et al. (2003) recorded increased salt tolerance in NaCl primed melons seeds as seedling dry weight were higher in primed seeds as compared to unprimed seeds. Positive effects of priming with NaCl have been reported on growth and yield of mature tomato plants when salt treatment were applied with seed sowing (Cano et al., 1991).

This study was undertaken to evaluate the effect of different priming agents under various salinity levels in comparison with unprimed seeds on emergence, seedling vigour in chilli cv. Hot Queen.

MATERIALS AND METHOD

Seeds of chilli cv. Hot Queen were surface sterilized by dipping in sodium hypochlorite (5%) solution for five minutes, rinsed two to three times in distilled water and dried on filter paper. These surface sterilized seeds were primed in distilled water (hydroprimed) and NaCl (1%) solution (haloprimed). Unprimed seeds served as control. Seeds were given 2 to 3 washings after priming and surface dried under forced air on filter paper. Unprimed, hydroprimed and haloprimed seeds were sown in pots at four different salinity levels (1.17, 3.0, 5.0 and 7 dS m^{-1}). Salinity was developed in each pot by irrigating the pots with NaCl solution of respective concentration. Pots were kept under lab conditions i.e at 25$\pm$2°C and 16 hours photoperiod. Data were recorded after 30 days on emergence rate (ER), final emergence percentage (FEP), root length, shoot length, fresh and dry weight of seedlings and seedling vigour. The experiment was laid out in completely randomized design with four replicates. Data recorded were analyzed statistically using Fisher's analysis of variance technique and Duncan's Multiple Range Test at 5% probability level to compare the differences among treatment means (Steel et al., 1997).

RESULTS

Seeds, primed and unprimed, sown at different salinity levels showed statistically significant difference for emergence. Seeds primed in NaCl (haloprimed) and distilled water (hydroprimed) exhibited maximum emergence rate in normal growing medium (control) i.e. 37.25% and 34.65%, respectively (Table 1), statistically at par each other, while significantly higher than unprimed seeds (21.30). Emergence rate of haloprimed seeds was maximum at all salinity levels than both hydroprimed seeds and control.

Haloprimed seeds showed more final emergence percentage than unprimed as well as hydroprimed seeds at all salinity levels above the threshold level i.e. 1.17 dS m^{-1} (Table 1). Final emergence percentage of haloprimed seeds at 7 dS m^{-1} (90%) was at par with FEP of unprimed (83.30%) and hydroprimed (82.50%) seeds at 3 dS m^{-1}, indicating the supremacy of haloprimed seeds over hydroprimed and unprimed seeds. Performance of both hydroprimed and unprimed seeds was statistically similar at different salinity levels.

There was no statistical difference among different treatments for root length; although root size varied from 3.52 cm to 4.82 cm (Table 1). Maximum root length (4.82 cm) was observed in seedlings raised from unprimed seeds at 1.17dS m^{-1} salinity level followed by 4.76 cm in seedlings raised from haloprimed seeds at 7 dS m^{-1} and hydroprimed seeds (4.70 cm) at 1.17 dS m^{-1} salinity level. Minimum root length i.e. 3.52 cm was recorded in unprimed seeds at 5dS m^{-1}.

Priming treatments significantly affected shoot length at different salinity levels (Table 1). Shoot size was maximum (9.55 cm) in hydroprimed seedlings at 1.17dS m^{-1} followed by hydroprimed seeds at 3 dS m^{-1} (8.77 cm). Shoot length of haloprimed seeds at 3 dS m^{-1} (7.72 cm) and 5dS m^{-1} (7.37 cm) was statistically at par with shoot length of unprimed seeds at 1.17 dS m^{-1} (8.00 cm).

Priming significantly affected number of secondary roots (Table 2). Maximum number of roots per plant (24.0) was observed in seedlings raised from haloprimed seeds at 1.17 dS m^{-1}, statistically at par with those from haloprimed seeds at 3 dS m^{-1} (23.25) and hydroprimed seeds at 1.17 dS m^{-1} (22.65). But, at higher salinity levels performance of hydroprimed and haloprimed seeds at 5 dS m^{-1} was statistically at par with number of secondary roots in unprimed seeds at 7dS m^{-1} i.e. 14.0, 14.15 and 14.0 roots per plant, respectively.

Statistically significant results were obtained for fresh weight per plant (Table 2). Haloprimed seeds produced seedlings with maximum fresh weight at all salinity levels i.e. 2192, 2587, 2310 and 2117 mg as compared to other treatments (Table 1). Fresh weight of haloprimed seeds at 3 dS m^{-1} and hydroprimed seeds at 3 and 5dS m^{-1} were statistically at par with unprimed seeds at 1.17, 3 and 5 dS m^{-1}, respectively.

Dry weight of seedlings in different treatments was significantly affected different treatments at different salinity levels (Table 2). Haloprimed and hydroprimed seeds at 3 and 5 dS m^{-1} produced seedlings with dry weights statistically at par with each other i.e. 382, 357, 360 and 380 mg per seedling. While at higher salinity level (7 dS m^{-1}) dry weight of seedlings was drastically reduced; all treatments behaved statistically alike at this salinity level.

Haloprimed seeds induced maximum seedling vigour at all salinity levels (Table 2). Hydroprimed seeds also improved vigour over the unprimed seeds. Vigour induced in seeds by halopriming at 7 dS m^{-1} was statistically similar to vigour induced by hydropriming at 5 dS m^{-1} and that of unprimed seeds at 3dS m^{-1} i.e. 936, 936.40 and 916.67, respectively. Unprimed seeds at 5 and 7 dS m^{-1} and hydroprimed seeds at 7 dS m^{-1} produced plants having minimum vigour.

DISCUSSION

Seed germinability is reduced under salt stressed conditions due to physiological injuries and such seeds are desiccation sensitive (Wiebe and Tiesses, 1979). Increased emergence of primed seeds over unprimed seeds is in accordance with the findings of Afzal et al. (2005). Priming in distilled water enhanced emergence rate in asparagus seeds (de Carvalho Bittencourt et al., 2005) support our results of improved performance of hydroprimed seeds over the unprimed ones. Salinity inhibited seedling growth but seed priming induced salt tolerance in chilli seedlings as observed by Afzal et al. (2005) in wheat seedlings. Improvement in performance of primed seeds over the unprimed seeds might be due to the repair mechanisms that occur during seed imbibition (Bray, 1995). Faster emergence rate after priming may be due to increased rate of cell division in the root tips of seedlings from primed seeds as reported in wheat (Bose and Mishra, 1992) and tomato (Farooq et al., 2005).

Seedling emergence percentage was markedly affected by salinity. Results clearly depicted that salinity reduced emergence rate but had no effect on final emergence percentage and halopriming enhanced emergence rate at all salinity levels over other treatments. These results are in accordance with the findings of Flynn et al. (2003). Increased emergence percentage of halo- and hydro-primed seeds under salt stress may be due to reduced uptake of NaCl by the germinating seeds or due to increased uptake of oxygen, and the efficiency of mobilizing nutrients from cotyledons to the embryonic axis (Kathiresan et al., 1984).

Seedling growth was suppressed under saline conditions, which is strongly in accordance with Cicek and Cakirlar (2002) who reported that salinity reduced shoot length, fresh and dry weight of maize seedlings. Primed seeds preformed better than unprimed seeds as shoot length in response to haloprimed seeds at higher salinity levels were at par with shoot length of unprimed seeds at lowest salinity level (control). However, results signify the supremacy of halopriming over hydropriming. Moreover, under low (3 dS m^{-1}) and moderate (5 dS m^{-1}) saline conditions haloprimed seeds performed comparatively better than hydro- and unprimed seeds. This enhanced tolerance of seedlings raised from haloprimed seeds may be due to induced resistance by NaCl, as reported in literature for salicylic acid that induce resistance to pathogens (Shirasu et al., 1997). Results signify the potential role of priming in amelioration of the destructive effect of salinity on growth. Halopriming, using NaCl was found to be more effective than hydropriming.

REFERENCES

Al-Karaki, G.N. 2001. Germination, sodium and potassium concentration of barely seeds as influenced by salinity, J. Plant Nutr., 24:511-522.

Afzal, I., S.M.A. Basra, N. Ahmad and M. Farooq. 2005. Optimization of hormonal priming techniques for alleviation of salinity stress in wheat (*Triticum aestivum* L.). Caderno de Pesquisa Ser. Bio., Santa Cruz do Sul, 17(1):95-105.

Afzal, I., S.M.A. Basra and A. Iqbal. 2005. The effects of seed soaking with plant growth regulators on seedling vigour of wheat under salinity stress. Journal of Stress Physiology and Biochemistry, 1(1):6-14.

Anonymous. 2006a. Economic survey of Pakistan. Federal Bureau of Statistics, Islamabad.

Anonymous. 2006b. Red chillies export declines. The Nation, May 10, 2006.

Bose, B. and T. Mishra. 1992. Response of wheat seed to presowing seed treatment with $Mg(NO_3)_2$. Annals of Agricultural Research 5:11-16.

Bray, C.M. 1995. Biochemical process during the osmopriming of seeds. In: J. Kgel, G. Galili (eds.). Seed development and germination.Marcel Dekker. New York, pp.767-789.

Cano, E.A., M.C. Bolarin, F. Perez-Alfocea and M. Caro. 1991. Effect of NaCl priming on increased salt tolerance in tomato. J. Hort. Sci., 66:621-628.

Carter, A.K. 1994. Stand establishment of chile. New Mexico Cooperative Extension Service, Las Cruces, New Mexico.

Cicek, N. and H. Cakirlar. 2002. The effect of salinity on some physiological parameters in two maize cultivars. Bulgarian Journal of Plant Physiology 28:66-74.

de Carvalho Bittencourt, M.L., D.C.F. dos Santos Dias, L.A. dos Santos Dias and E.F. Araujo. 2005. Germination and vigour of primed Asparagus seeds. Sci. Agric. (Piracicaba, Braz.), 62(4):319-324.

Demir, I. and G. Okcu. 2004. Aerated hydration treatment for improved germination and seedling growth in aubergine (*Solanum melongena*) and pepper (*Capsicum annuum*). Ann. Appl. Biol., 144:121-123.

Farooq, M., S.M.A. Basra, B.A. Saleem, M. Nafees and S.A. Chishti. 2005. enhancement of tomato seed germination and seedling vigour by osmopriming. Pak. J. Agri. Sci., 42(3-4):36-41.

Flynn, R., R. Phillips, A. Ulery, R. Kochevar, L. Liess and M. Villa. 2003. Chile seed germination as affected by temperature and salinity. New Mexico Cooperative Extension Service Report No. 2, Las Cruces, New Mexico.

Haman, D.Z. 2000. Irrigating with high salinity water. Bulletin 322, Institute of Food and Agricultural Sciences, University of Florida, Gainesville, pp.5.

Heydecker, W. 1972. Vigour. In: E.H. Roberts. Viability of seeds. Syracuse University Press, Syracuse, pp.209-252.

Kanber, R., C. Kirda and O. Tekinel. 1992. The problem of salinity and irrigation water quality. Report No. 21, Agriculture Faculty, Cukurova University, Adana, pp.6.

Kathiresan, K., V. Kalyani and J.L. Gnanarethium. 1984. Effect of seed treatments on field emergence, early growth and some physiological processes of sunflower (*Helianthus annus* L.). Field Crops Research 9:255-259.

Rhoades, J.D., A. Kandiah and A.M. Mashali. 1992. The use of saline waters for crop production. Food and Agriculture Organization of the United Nations (FAO), Irrigation and Drainage Paper 48. FAO, Rome, Italy.

Shirasu, K., H. Nakajima, V.K. Rajasekar, R.A. Dixon and C. Lamb. 1997. Salicylic acid potentiates an agonist-dependent gain control that amplifies pathogen signal in the activation of defense mechanisms. The Plant Cell 9:261-270.

Sivritepe, N., H.O. Sivritepe and A. Eris. 2003. The effects of NaCl priming on salt tolerance in melon seedlings grown under saline conditions. Sci. Hort., 97:229-237.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and procedures of statistics. A biometrical approach. 3rd Ed. McGraw Hill Book Co. Inc., Singapore

Thornton, J.M. and A.A. Powell. 1992. Short term aerated hydration for improvement of seed quality in *Brassica oleracea* L. Seed Science Research 2:41-49.

Wiebe, H.J. and H. Tiesses. 1979. Effects of different seed treatments on embryo growth and emergence of carrot seeds. Gartenbauwissenschaft 44:280-286.

Zia, M.A. 2006. Managing aflatoxin in chilli crop. The Dawn, July 31, 2006.

Table 1: Effect of seed priming on seedling emergence and growth

Treatment	Salinity level (dS m^{-1})	Emergence rate (%)	Final emergence (%)	Root length (cm)	Shoot length (cm)
Unprimed seeds (Control)	1.17 (control)	21.30 cde	86.65 ab	4.82	8.00 bcd
	3	19.15 de	86.65 ab	4.57	7.07 de
	5	18.30 de	83.30 ab	3.52	6.37 e
	7	16.35 e	70.80 bc	4.60	6.25 e
Hydropriming	1.17 (control)	34.65 a	94.00 a	4.70	9.55 a
	3	28.00 b	86.25 ab	3.92	8.77 ab
	5	26.55 bc	82.50 ab	3.75	7.05 de
	7	21.25 cde	62.50 c	3.85	4.92 f
Halopriming	1.17 (control)	37.25 a	95.00 a	4.02	8.47 bc
	3	33.75 a	94.00 a	4.60	7.72 bcd
	5	30.90 ab	93.50 a	4.00	7.37 cde
	7	22.50 bcd	90.00 a	4.76	6.35 e

Table 2: Effect of seed priming on root growth, biomass production and seedling vigour

Treatment	Salinity level (dS m^{-1})	Number of secondary roots	Fresh weight (mg)	Dry weight (mg)	Seedling vigour
Unprimed seeds (Control)	1.17 (control)	19.15 abc	2855 a	410 ab	1050.46 abc
	3	19.85 ab	2432 abc	362 abc	916.67 bc
	5	19.12 abcd	2447 abc	292 bcd	876.00 c
	7	16.00 bcd	1967 cd	310 bcd	540.62 d
Hydropriming	1.17 (control)	22.65 a	2110 bcd	430 a	1248.40 ab
	3	15.40 bcde	2665 ab	360 abc	989.12 abc
	5	14.00 cde	2485 abc	380 ab	936.40 bc
	7	9.50 f	1575 d	232 d	790.87 cd
Halopriming	1.17 (control)	24.00 a	2192 bc	355 abc	1283.70 a
	3	23.25 a	2587 abc	382 ab	1033.20 abc
	5	14.15 cde	2310 abc	357 abc	1086.55 abc
	7	14.07 cde	2117 bcd	247 cd	936.00 bc