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Comparative Study of Pre-Sowing Seed Enhancement Treatments in Fine Rice (*Oryza sativa* L.)

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Abstract

Changes in germination and seedling vigour after priming of fine rice seeds were studied. For priming, rice seeds were soaked in tap water by traditional method, hardened for 18 and 24 h at 25°C (two cycles), and osmoconditioned (with –1.1 MPa KNO_3) for 24 and 48 h at 25°C. All the treatments significantly effected the time to start the germinations, T_{50}, MGT, fresh and dry weight of root and shoot, root and shoot length, root/ shoot ratio and EC of seed leachates. Seed hardening for 24 h resulted in higher germination percentage, root and shoot length, root/shoot ratio and lower MGT, T_{50}, and EC.

Keywords: Seed enhancement, Rice, MGT, T_{50} Hardening, Osmoconditioning

Introduction

Traditionally, rice seedlings have always been transplanted in Pakistan, but in recent years, direct seeding has been extensively studied to reduce the production costs, i.e. removing the expenses for raising and transplanting rice seedlings. In the traditional method, rice seeds are presoaked in water and then germinated at the optimum germination temperature. The well-germinated seeds are sown in a protected nursery bed of soil. However, when dry seeds are planted directly in field, poor emergence rate and delayed germination are often serious problems, especially at early planting. The seeds germinate slowly and display significant individual variation. However, uniform and rapid germination are necessary to obtain the optimum plant population in the direct seeding of rice.

Priming enhances seed performance by increasing germination rate and uniformity. Furthermore, these enhancements persist under less than optimum flied conditions, such as salinity (Wiebe and Muhyaddin, 1987), excessively high or low temperatures (Bradford, 1986; Pill and Finch-Savage, 1988; Valdes *et al*., 1985), and reduced water availability (Fertt and Pill, 1989).

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Seed priming improves the overall germination rate and uniformity of growth, and reduces the time to start germination particularly in many vegetable crops such as celery (Drew and Dearman, 1993; Rennick and Tiernan, 1978), parsley (Akers, 1987), tomato (Muhyaddin and Wiebe, 1989) and leek (Nienow *et al*., 1991). Similar effects were observed in some field crops such as corn, barley, wheat, sorghum and soybean (Bodsworth and Bewley, 1981; Basra *et al.*, 2002) under the adverse conditions such as sub-optimal temperatures or soil moisture conditions.

World famous Basmati is the God gifted heritage of Pakistan. It is recognized all over the world for its fragrance and aroma. Although a little work has been done on the priming and seed enhancement of coarse rice (Lee *et al*., 2000; Lee and Kim, 1999), however, such information is limited in case of fine rice. Therefore, in this experiment improved invigoration treatments, as osmoconditioning and hardening were compared with traditional soaking to improve the seedling establishment at planting of fine rice seeds.

Materials and Methods

Seeds of fine rice cultivar BASMATI-385 were obtained from the Rice Research Institute, Kala Shah Kakoo. The initial seed moisture was 8.33%.

Seed Treatment

Following seed treatments were employed:

Traditional seed soaking

Two hundred fifty gram seeds were soaked in 500 mL water for 24 h at room temperature. These seeds were then placed between two layers of saturated gunny bags up to chitting.

Seed hardening

A weighed quantity (250 g) of seeds was soaked in 500 mL of distilled water at 25°C for 18 or 24 h followed by drying under shade. This soaking and drying of seeds was repeated twice (Lee *et al*., 1998).

Osmoconditioning

The seeds were soaked in aerated –1.1 MPa KNO_3 solution (Mauromicale *et al*., 1994) for 24 or 48 h.

Post priming operations

After treatments, seeds were given threes surface washings with distilled water (Khan *et al*., 1992) and redried to original weight with forced air under shade. These seeds were sealed in polythene bags and stored in refrigerator for further use.

Vigour evaluation

Seed germination

Germination was observed daily at 27°C according to the AOSA method (AOSA, 1990).

Time to start 50% germination (T_{50})

T_{50} was calculated according to Coolbear *et al*. (1984) using the following formula

$$T_{50} = t_i + \frac{(N+1)/2 + n_i}{(n_j - n_i)}(t_j - t_i)$$

Where N is the final number of germination and n_i, n_j cumulative number of seeds germinated by adjacent counts at times "t_i" and "t_j" when $n_i < (N+1) / 2 < n_j$.

Mean germination time (MGT)

MGT was calculated according to the equation of Ellis and Roberts (1981).

$$MGT = \frac{\sum Dn}{\sum n}$$

Where "n" is a number of seeds which were germinated in day "D" and "D" is the number of days counted from the beginning of germination.

Seedling vigour

Control and treated seeds were sown in plastic trays having moist sand and were placed in a net house. Weather data recorded during the course of studies is given in Table I. The seedlings were evaluated 10 days after sowing as described in the seedling evaluation Handbook of AOSA (1990).

Electrical conductivity of seed leachates

After washing with distilled water, 5 g seeds were soaked in 50 mL distilled water at 25°C. Electrical conductivity of seed leachates was measured 0.5, 1.0, 1.5, and 2, 6, 12 and 24 h after the soaking using the conductivity meter (Model Twin cod B-173) and expressed as µS/cm/g.

Results

Germination

All the seed treatments significantly effected the time to start the germination, T_{50}, MGT and final germination percentage (Table 2). Statistically similar and earlier germination was observed in seeds traditionally soaked, hardened for 18 or 24 h and osmoconditioned for 24 h than control and osmoconditioned for 48 h in which seeds germinated one day later.

Seed hardening for 24 h resulted in lower T_{50} and MGT, and higher germination percentage than all other treatments including control. Osmoconditioning for 48 h resulted in delayed germination and ultimately higher T_{50} and MGT, and lower germination percentage even than that of untreated seeds.

Seedling vigour

All the seed treatments significantly effected the seeding vigour of fine rice (Table 2, 3). Statistically longest roots and shoots were observed in seeds hardened for 24 h. All the seed treatments significantly improved the seedling length except osmoconditioning for 48 h that resulted in shorter seedlings even than that of untreated seeds. Similar trend was noted in root/shoot ratio and root fresh and dry weight where seed hardening for 24 h invigorated the fine rice seedlings, while osmonditioning for 48 h resulted in performance even less than untreated seeds. All the seed treatments resulted in higher root fresh weight but contrary response was noted in root dry weight where all the treatments resulted in lower root dry weight (Table 3).

Electrical Conductivity (EC)

The lowest EC of solute leakage was observed in the seeds osmoconditioned for 24 h (Figure 1). Maximum rate was recorded in untreated seeds. The trend shows that all the seed treatments resulted in lowering the rate of seed leachates.

Discussion

Pre-sowing seed treatments shortened the MGT and T_{50} and the treated seeds germinated earlier. It is possible that coleoptile from the treated seeds elongated faster and longer than ones from non-treated and over primed seeds (Rennick and Tiernan, 2002). The earlier and faster germination in the treated seeds might be due to increased metabolic activities in the primed seeds than non-primed (Lee and Kim, 2000). Primed seeds usually exhibit increased germination rate, greater germination uniformity, and sometimes greater total germination percentage of a large number of species (Heydecker and Coolbear, 1977; Brocklehurst *et al*., 1984; Zheng, *et al*., 1994; Taylor *et al*., 1998; Welbaum and Bradford, 1991; Jett *et al*., 1996; Özbingöl *et al*., 1998; Hardegree Van Vactor, 2000).

Priming treatments either were ineffective or significantly reduced the seed vigour. It is evident from reduction in germination percentage and slower germination that resulted in week seedlings (Table 2, 3). Over-priming might be due to KNO_3 toxicity during prolonged soaking in KNO_3 solution that might have injured the cellular organelies (Singh and Gill, 1988). The results presented here confirm earlier data (Haigh and Barlow, 1987), which indicated that priming with alone or combinations of KNO_3, K_2HPO_4 and K_3PO_4 proved toxic to sorghum seeds. They also reported that germination was more closely related to ionic strength of the potassium solutions than to the osmotic potential of the imbibitional solution. The deleterious effects of KNO_3 treatment may be due to penetration of ions in to the seeds (Brocklehurst and Dearman, 1984).

The earlier and faster germination by hardening for 24 h resulted in increased dry matter accumulation as shown by fresh and dry weight of the shoots and the roots. Increased root length and weight might be due to the induced replication of DNA/RNA in the root tips (Bose and Mishra, 1992). Hardening also improved the repair mechanism both structural and genetic. Improved membrane integrity in the treated seeds resulted in lower seed leachates (Rudrapal and Nakammra, 1988).

Conclusion

Performance of fine rice can be enhanced by different invigoration treatments; however, seed-hardening treatment for 24 hours was found significantly better in the vigour enhancement and can be an alternative of traditional seed soaking method being used for decades.

Table 1: Weather data during the course of study

Date	Temperature (ºC)		R.H. (%)	Rainfall (mm)	Sunshine hours
	Min.	Max.			
25-7-02	31	38	60	00	8-30
26-7-02	30	36	62	00	10-00
27-7-02	28	40	61	00	10-15
28-7-02	30	41	60	00	7-15
29-7-02	28	41	54	00	Cloud
30-7-02	26	41	53	00	2-00
31-7-02	28	38	61	0.4	4-00
01-8-02	28	39.5	64	1.0	6-45
02-8-02	29	39.5	57	3.6	8-30
03-8-02	31.5	42	48	00	7-30

Source: Agri-Meterological Cell, Department of Crop Physiology, University of Agriculture, Faisalabad

Table 2: Effect of seed treatments on germination and seedling vigour in fine rice seed

Treatments	Time to start germination (days)	T50 (days)	MGT (days)	Final Germination (%)	Shoot Length (cm)	Root Length (cm)	Root/ Shoot Ratio
Control	2.000 A	1.500 B	2.000 C	86.67 B	9.433 C	2.800 C	1.007 CD
Traditional soaking	1.00 B	0.976 D	2.233 D	100.00A	11.33 B	4.967 A	0.7133 A
Seed Hardening 18 h	1.00 B	1.277 C	2. 867 B	83.33 B	8.667 C	3.100C	0.3700 BC
Seed hardening 24 h	1.00 B	0.907 E	2.133 D	100.00 A	14.07 A	5.33 A	0.3733 AB
Osmoconditioning 24 h	1.00 B	1.470 B	2.900 B	86.67 B	11.90 B	3.967 B	0.5467 AB
Osmoconditioning 48 h	2.00 A	2.033 A	3.133 A	63.33 C	8.867 D	2.033 D	0.3533 D
LSD	*0.0056*	*0.056*	*0.168*	*8.386*	*1.321*	*0.450*	*0.050*

The letters with different alphabets are statistically different at p 0.05; MGT = Mean germination time

Table 3: Effect of seed treatments on seedling vigor of fine rice seeds

Treatments	Shoot fresh weight (mg)	Root fresh weight (mg)	Shoot dry weight (mg)	Root dry weight (mg)
Control	22.50 B	8.733 D	4.76 C	4.83 A
Traditional soaking	26.07 A	26.67 A	7.33 AB	5.26 A
Seed Hardening 18 h	18.73 BC	14.00 C	6.50 B	2.36 C
Seed hardening 24 h	26.47 A	11.70 C	9.70 A	3.80 B
Osmoconditioning 24 h	28.00A	23.70 B	6.63 B	3.63 B
Osmoconditioning 48 h	16.50 C	27.07 A	4.90 C	1.733 D
LSD	2.871	1.821	1.872	1.53

The letters with different alphabets are statistically different at p 0.05

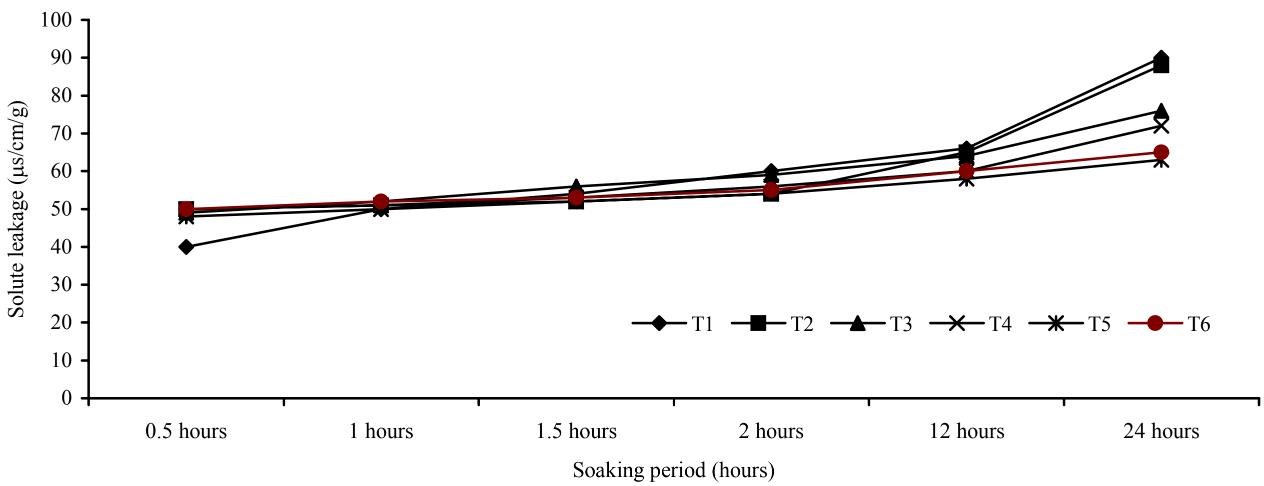

Figure 1: Effect of soaking period on electrical conductivity in rice variety Basmati-385

References

Akers, G.A. Germination of parsley seed primed in aerated solutions of polyethylene glycol. Hortsci., 1987, 22: 250-252.

Ashraf, M., Akhtar, N., Tahira, F. and Nasim, F. Effect of NaCl pretreatment for improving seed quality in cereals. Seed Sci. Techno., 1999, 20(3):435-440.

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

Basra, S.M.A., Zia, M.N., Mahmood, T., Afzal, I. and Khaliq, A. Comparison of different invigoration techniques in wheat (Triticum aestvum L.) Seed. Pakistan J. Arid. Agric., 2002. (Accepted for publication).

Bernfeld, P. Amylases α and β: Methods in Enzymology, Vol. 1, Cdowick, S.P. and Kaplan, N. (Eds.). Academic Press, New York, pp: 149, 1955.

Bodsworth, S. and Bewley, J.D. Osmotic priming of seeds of crop species with polyethylene glycol as a means of enhancing early and synchronous germination at cool temperatures. Canadian J. Bot., 1981, 59: 672-676.

Bose, B. and Mishra, T. Response of wheat seed to presowing seed treatment with Mg $(NO_3)_2$. Ann. Agric. Res., 1992, 13: 132-136.

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

Brocklehurst, P.A. and Dearman. J. A comparison of different chemicals for osmotic treatment of vegetable seed. Ann. Appl. Biol., 1984, 105: 391-398.

Brocklehurst, P.A., Dearman, J. and Drew, R.L.K. Effects of osmotic priming on seed germination and seedling growth in leek. Sci. Hort., 1984, 24: 201-210.

Drew, R.L.K. and Dearman, J. Effect of osmotic priming on germination characteristics of celery (*Apium graveolens* L. var. rapaceum). Seed Sci. Technol., 1993, 21: 411-415.

Dubois, M., Giles, K.A., Hamilton, J.K., Robers, P.A. and Smith, F. Colorimetric method for determination of sugars and related substances. Anal. Chem., 1956, 28: 350-356.

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

Frett, J.J. and Pill, W.G. Germination characteristics of osmotically primed and stored impatiens seeds. Scientia Hort., 1989, 40:171-179.

Haigh, A.M. and Barlow, E.W.R. Germination and priming of tomato, carrot, Onion, and sorghum seeds in a range of osmotica. J. Amer. Sco. Hort. Sci., 1987, 112: 202-208.

Hardegree, S.P. and S.S. Van Vactor. Germination and emergence of primed grass seeds under field and simulated-field temperature regimes. Ann. Bot., 2000, 85: 379-390.

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

Jett, L.W., Welbaum, G.E. and Morse, R.D. Effects of matric and osmotic priming treatments on broccoli seed germination. J. Am. Soc. Hort. Sci., 1996, 121: 423-429.

Khan, A.A. Preplant physiological conditioning. Hort. Review, 1992, 13: 131-181.

Lee, S.S. and Kim, J.H. Morphological change, sugar content, and α-amylase activity of rice seeds under various priming conditions. Korean J. Crop. Sci., 1999, 44: 138-142.

Lee, S.S. and Kim, J.H. Total sugars, α-amylase activity and germination after priming of normal and aged rice seeds. Korean J. Crop Sci., 2000, 45: 108-111.

Lee, S.S., Kim, J.H., Hong, S.B. and Yun, S.H. Effect of humidification and hardening treatment on seed germination of rice. Korean J. Crop Sci., 1998, 43: 157-160.

Mauromicale, G., Canallaro, V. and Lerna, A. Effects of seed osmoconditioning on emergence characteristics of summer squash (*Cucurbits pepo* L.) Acta Hort., 1994, 362: 221-228.

Miller, G.L. Use of dinitrosalicylic acid reagent for the determination of reducing sugars. Analyt. Chem., 1956, 31: 426-428.

Muhyaddin, T. and Wiebe, H.J. Effect of seed treatments with polyethylene glycol (PEG) on emergence of vegetable crops. Seed Sci. Technol., 1989, 17:49-56.

Nerson, H. and Govers, A. Salt priming of muskmelon seeds for low temperature germination. Sci. Hortic., 1986, 28: 85-91.

Nienow, A.W., Bujalaski, W., Petch, G.M., Gray, D. and Drew, R.L.K. Bulk priming and drying of leek seeds: the effects of two polymers of polyethylene glycol and fluidized bed drying. Seed Sci. Technol., 1991, 19: 107-116.

Özbingöl, N., Corbineau, F. and Côme, D. Response of tomato seeds to osmoconditioning as related to temperature and oxygen. Seed Sci. Res., 1998, 8: 377-384.

Pills, W.G. and Finch-Savage, W.E. Effects of combining priming and plant growth regulator treatments on the synchronization of carrot seed germination. Ann. Appl. Biol., 1988, 113: 383-389.

Rennick, G.A. and Tiernan, P.I. Some effects of osmoprining on germination, growth and yield of celery (*Apium graveolens*), Seed Sci. Technol., 1978, 6: 695-700.

Rivas, M., Sundstorm, F.J. and Edwards, R.L. Germination and crop development of hot pepper after seed priming. Hort. Sci., 1984, 19: 279-281.

Rudrapal, D. and Nakara, S. The effect of hydration-dehydration pretreatments on eggplant and radish seed viability and vigour. Seed Sci. Technol., 1988, 16: 123-130.

Singh, H. and Gill, H.S. Effect of Seed treatment with slats on germination and yield of wheat. Agric. Sci. Digest, 1988, 8(4):173-175.

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

Valdes, V.M., Bradford, K.J. and Mayberry, K.S. Alleviation of thermodormancy in coated lettuce seeds by seed priming. Hort. Sci., 1985, 20: 1112-1114.

Welbaum, G.E. and Bradford, K.J. Water relations of seed development and germination in muskmelon (*Cucumis melo* L.). VI. Influence of priming on germination responses to temperature and water potential during seed development. J. Exp. Bot., 1991, 42: 393-399.

Wiebe, H.J. and Muhyaddin, T. Improvement of emergence by osomotic seed treatments in soils of high salinity. Acta Hort., 1987, 198: 91-100.

Zheng, G., Wilen, R.W., Slinkard, A.E. and Gusta, L.V. Enhancement of canola seed germination and seedling emergence at low temperature priming. Crop Sci., 1994, 34: 1589-1593.

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