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EFFECT OF SEED PRIMING ON GERMINATION AND VIGOUR IN LOW AND HIGH LONGEVITY RICE GENOTYPES

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ABSTRACT

Seed priming is a simple, low-cost, low-risk intervention and powerful technique to improve seedling emergence & vigour and yield of several crops. Three rice genotypes each in low (AC 35024, AC 39021, Gangavati Sona) and high (Jaya, PS 267 and AC 39004) longevity were primed with water (hydropriming), 4 % Pseudomonas fluorescens, 20 % Azospirillum sp, 50 mM NaCl, 20 % PEG 8000, 75 % Coconut water, 2 % Pulse sprout extract and 0.5 % Nutrigold for 12 hours. In general, high longevity rice seeds responded well to the priming treatments compared to low longevity seeds. The seeds of PS 267 primed with 4 % P. fluorescens recorded highest germination (99 %), root length (20.5 cm), shoot length (8.5 cm), dry matter production (10.5 mg/seedling), vigour index I (2868) and II (1037) compared to all other genotypes. Among the priming treatments, seeds primed with 4 % P. fluorescens for 12 h recorded higher seed germination and vigour followed by 2 % pulse sprout extract, irrespective of seed longevity nature and genotypes.

KEYWORDS: Seed Priming, Rice, Germination & Seed Vigour

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Original Article

INTRODUCTION

Rice is one of the most important food crops for over half of the world's population accounts for around 23% of the global calorie intake (Li *et al*., 2011; Bernier *et al*., 2008) and it is staple food for more than 3 billion people in Asia, where more than 90% of the world's rice is produced and consumed (Li and Xu, 2007). The low crop productivity in rice faced by Indian Agriculture is mainly because of poor soil health, poor adoption of hybrids and various stress conditions. Though the high quality seeds are used for sowing in the field, it undergoes several stresses during the emergence and establishment leading to poor survival and reduced plant stand. Seed priming may be used as an important tool to improve seed performance and stand establishment in the field, especially during the summer (Nascimento and Pereira, 2007). In priming, seeds are exposed to restricted water availability under controlled conditions which allows some of the physiological processes of germination to occur and before the germination is completed, the seeds are usually re-dried for short term storage before sowing (Halmer, 2003). The main effect of seed priming on germination and primary seedling establishment indicated by increased germination and other related indicators like mean germination time and vigor, root and shoot length, germination rate (Farooq, 2006). The seed priming can improve physiological responses under the environmental stress conditions and increase seed tolerance to environmental stress. There are several priming methods are available depending on the substances used *viz.* hydropriming (water), halopriming (salt), osmopriming

(osmoticants), organopriming (organic substances) and biopriming (microorganisms). In rice crop, priming provides a vigorous 'head start' that typically exhibit faster and uniform emergence, accomplish better stand establishment and gives high yields (McDonald, 2000). Seed priming is now a widely used technique that accelerates the germination rate and improves seedling uniformity in many crops. There are several seed priming methods available with public domain but, only a limited study was conducted to compare various priming methods and its effect on genotypes genetically diverse for seed longevity. Hence, a study was undertaken to find out the best seed priming method to increase the seed germination and vigour in rice.

MATERIALS AND METHODS

The genetically pure seeds of six rice genotypes *viz.* AC 35024, AC 39021 and Gangavati Sona (low seed longevity); Jaya, PS 267 and AC 39004 (high seed longevity) were multiplied at Zonal Agricultural Research Station, Mandya of UAS, Bengaluru during *kharif*, 2014 and used in the study. The various seed priming methods, substances and its concentration were selected from the earlier studies. The seeds were hydro-primed with water (Farooq, 2006), bio-primed with 4% *P. fluorescens* and 20% *Azospirillum* sp. (Kokila, 2015), halo-primed with 50mM NaCl (Jisha, 2014), osmo-primed with 20% PEG 8000 (Elkheir, 2016), coconut water (75 %) (Vijayan, 2005), Pulse sprout extract (2 %) (Jayanthi, 2008) and nutrigold (A commercial product of TNAU, Coimbatore) (0.5%) for 12 h.

Preparation of Pulse Sprout Extract

Horse gram seeds were soaked overnight and incubated in a wet cloth for 12 hours to enable sprouting. 100 g of sprouts were ground in a mixer-grinder by using ice cubes from 100 ml of water to prepare extracts of 100 per cent concentration.

After priming, the seeds were dried under shade to bring the seed moisture content to 11-12 %. Then the seeds were evaluated for the following parameters.

Germination (ISTA, 2007)

The germination test was conducted using paper (between paper method) medium. Four replicates of 100 seeds each were germinated in a room germinator maintained at 25°C and 95±2% RH. At the end of fourteenth day of sowing, the number of normal seedlings in each replication was counted and expressed in percentage.

Root Length

Ten normal seedlings were selected at random from each replication at the time of germination count and used for measuring the root length. Root length was measured from the collar region to tip of primary root and the mean values were expressed in centimetre.

Shoot Length

The ten seedlings used for measuring root length were also used for measuring shoot length. The shoot length was measured from the collar region to tip of leaf and the mean values were expressed in centimetre.

Dry Matter Production

Ten normal seedlings from the germination test were placed in a paper cover and dried under shade for 24 h and then, kept in an oven maintained at 80±2°C for 24 h. The dried seedlings were weighed and the mean values were expressed in mg seedlings^{-1}.

Seedling Vigour Index

The seedling vigour index was computed by adopting the formula suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Seedling vigour index-I = Germination (%) x Mean seedling length (cm)

Seedling vigour index-II = Germination (%) x Dry Matter Production (mg/seedling)

The data obtained from different experiments were analysed for the 'F' test of significance following the methods described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSIONS

The seed priming treatments, seed longevity and genotypes significantly influenced all the parameters *viz.* germination (%), root length (cm), shoot length (cm), dry matter production (mg/seedlings and vigour index I and II. The rate of enhancement in seedling growth parameters was higher in high longevity seeds when compared to low longevity seeds.

All the seed priming treatments recorded higher seedling growth parameters compared to control. In the present study, rice seeds primed with 4 % *P. fluorescens* for 12 h was found to be the best in improving the seed germination and seedling vigour irrespective seed longevity nature. The seeds primed with 4 % *P. fluorescens* for 12 h expressed 11%, 13%, 14%, 12%, 26% and 26% increase in germination per cent, root length, shoot length, dry matter production, seed vigour I and II, respectively (Figure 1&2). Bio-priming, a novel technique of seed treatment that integrates biological and physiological aspects of disease control, was recently started using as an alternative method for controlling many seed and soil borne pathogens (Moeinzadeh *et al.,* 2010). Seed treated microorganisms have the potential to become established in the rhizosphere of plants, as they may transfer onto the developing root as it emerges from the seed. The enhancement in germination and vigour parameters could be attributed to either direct suppression of deleterious pathogens or indirectly through the production of growth hormones and increased uptake, solubilization and translocation of less available minerals (Windham *et al.,* 1986 and Harman *et al.,* 1989).

In general, the genotypes having high seed longevity showed enhanced seedling growth rate compared to genotypes having poor seed longevity. Among the higher longevity rice seeds, PS 267 recorded highest germination (94 %), root (19.4 cm) and shoot length (8.1 cm), dry matter production (9.9 mg/seedling) and vigour index I (2594) and vigour index II (931) (Table 1 & 2) which are 19%, 8%, 0%, 16%, 26% and 38%, respectively higher compared to mean of low longevity genotypes. The vigourous seedling growth of bioprimed seeds might be due to plant growth promoting activity (PGPA) of *P. fluorescens*. *Pseudomonas spp* are capable of producing gibberellins, auxins and cytokinins such as isopentenyladenosine (IPA), dihydroxy zeatin riboside (DHZR) and zeatinriboside (ZR) which induces the plant growth activity (Karnwal and Kaushik, 2011).

In the interaction treatments, a high longevity variety PS 267 rice seeds primed with 4 % *P. fluorescens* recorded higher germination (99 %), root (20.5 cm) and shoot length (8.5 cm), dry matter production (10.5 mg/seedling) and vigour index I (2868) and vigour index II (1037). Salamone *et al*. (2001) reported that seed treatment with *Pseudomonas* G20-18 promoted vigourous growth in wheat and radish seedlings due to the production of phytohormones namely cytokinin. Production of plant growth regulators increase the availability of minerals and other ions, extensive rooting which facilitates water and nutrient uptake (Ramamoorthy *et al*., 2001).

Higher seedling physiological parameters in terms of germination and vigour were observed in 4 % *P. fluorescens* followed by 20 % *Azospirillum* sp, 2% Pulse sprout extract and 0.5 % Nutrigold which were on par with each other. Increasing of seed germination, seedling vigour and dry matter production. The seeds primed with pulse sprout extract recorded higher seedling length and germination. Because bioacitve substances in sprouted horsegram *viz*., amino acid, vitamins and minerals could have resulted in fortification of rice seeds (Jayanthi, 2008).

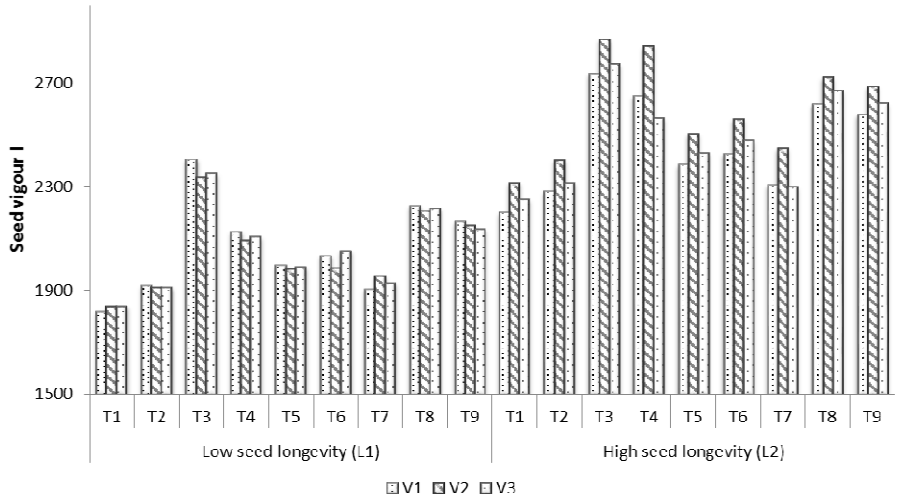

Figure 1: Effect of Seed Priming on Vigour Index I in High and Low Seed Longevity Rice Genotypes

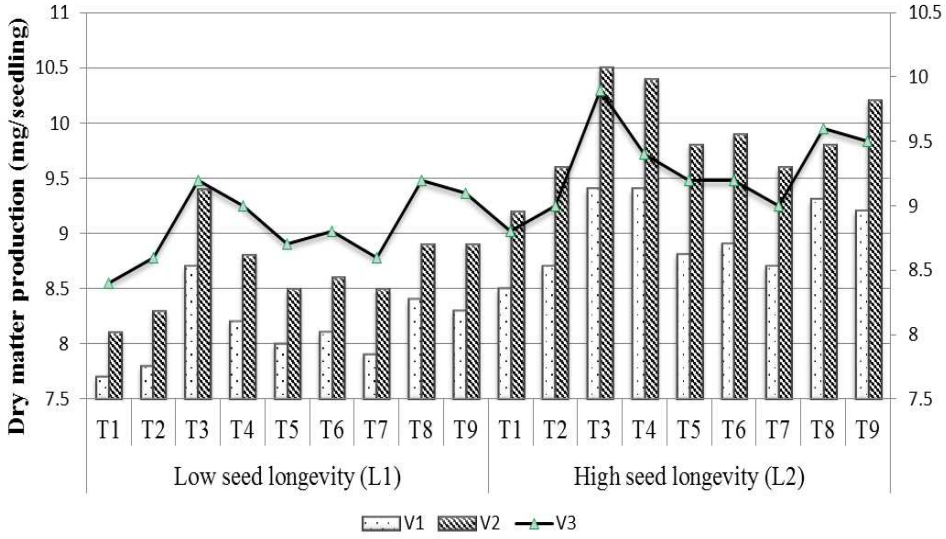

Figure 2: Effect of Seed Priming on Dry Matter Production in High and Low Seed Longevity Rice Genotypes

	V_1	V_2	V_3
Low seed longevity	AC 35024	AC 39021	Gangavati Sona
High seed longevity	Jaya	PS 267	AC 39004

T_1 - Control	T_2 - Hydropriming	T_3 - 4 % *P. fluorescens*
T_4 – 20 % *Azospirillum* sp.	T_5 - 50mM NaCl	T_6 - 20 % PEG 8000
T_7 – 75 % Coconut water	T_8 - 2% Pulse sprout extract	T_9 - 0.5 % Nutrigold

Table 1: Effect of Priming on Seed Germination (%) in Low and High Longevity Rice Genotypes

Treatment	Germination (%)								
	Low seed longevity (L_1)				High seed longevity (L_2)				G. Mean
	V_1	V_2	V_3	Mean	V_4	V_5	V_6	Mean	
T_1	77 (61)	72 (58)	75 (60)	**75** (60)	84 (67)	89 (71)	86 (68)	**86** (68)	**81** (64)
T_2	80 (63)	74 (59)	77 (61)	**77** (61)	86 (68)	91 (72)	87 (69)	**88** (70)	**82** (65)
T_3	88 (70)	80 (63)	83 (66)	**84** (66)	93 (76)	99 (84)	96 (79)	**96** (79)	**90** (73)
T_4	83 (66)	77 (61)	81 (64)	**80** (64)	91 (73)	99 (84)	92 (74)	**94** (77)	**87** (70)
T_5	81 (64)	75 (60)	78 (62)	**78** (62)	88 (69)	93 (75)	90 (71)	**90** (72)	**84** (67)
T_6	82 (65)	74 (60)	80 (63)	**79** (63)	88 (70)	94 (76)	90 (72)	**91** (72)	**85** (67)
T_7	79 (63)	75 (60)	77 (61)	**77** (61)	86 (68)	92 (74)	86 (68)	**88** (70)	**82** (66)
T_8	85 (68)	79 (62)	82 (65)	**82** (65)	92 (74)	97 (79)	94 (76)	**94** (76)	**88** (71)
T_9	85 (67)	78 (62)	81 (64)	**81** (64)	91 (73)	96 (78)	93 (75)	**93** (75)	**87** (70)
Mean	**82** (65)	**76** (61)	**79** (63)	**79** (63)	**89** (71)	**94** (77)	**90** (73)	**91** (73)	**85** (70)

	T	L	V	T X L	T X V
SEd	1.7	0.8	0.8	2.5	2.3
CD (P=0.05)	3.5	1.7	1.5	NS	NS
CD (P=0.01)	4.7	2.2	1.9	NS	NS

T_1 - Control	T_2 - Hydropriming	T_3 - 4 % *P. flurescens*
T_4 – 20 % *Azospirillum* sp.	T_5 - 50mM NaCl	T_6 - 20 % PEG 8000
T_7 – 75 % Coconut water	T_8 - 2% Pulse sprout extract	T_9 - 0.5 % Nutrigold
V_1 – AC 35024	V_2 – AC 39021	V_3 - Gangavati Sona
V_4 - Jaya	V_5 – PS 267	V_6 – AC 39004

Table 2: Effect of Priming on Seed Vigour II in Low and High Longevity Rice Genotypes

Treatment	Seed vigour II								
	Low seed longevity (L_1)				High seed longevity (L_2)				G. Mean
	V_1	V_2	V_3	Mean	V_4	V_5	V_6	Mean	
T_1	593	584	632	**603**	713	818	758	**763**	**683**
T_2	623	614	655	**631**	740	868	778	**795**	**713**
T_3	765	752	767	**761**	880	1037	946	**954**	**858**
T_4	687	674	724	**695**	859	1028	863	**917**	**806**
T_5	649	638	683	**657**	773	906	820	**833**	**745**
T_6	661	639	704	**668**	787	926	835	**849**	**759**
T_7	620	637	661	**640**	747	884	775	**802**	**721**
T_8	716	701	749	**722**	849	945	900	**898**	**810**
T_9	704	692	733	**710**	837	970	885	**897**	**804**
Mean	**669**	**659**	**701**	**676**	**798**	**931**	**840**	**857**	**766**

	T	L	V	T X L	T X V
SEd	30.5	14.4	11.9	43.1	35.6
CD (P=0.05)	61.8	29.1	23.4	NS	NS
CD (P=0.01)	82.9	39.1	30.9	NS	NS

T_1 - Control	T_2 - Hydropriming	T_3 - 4 % *P. flurescens*
T_4 – 20 % *Azospirillum* sp.	T_5 - 50mM NaCl	T_6 - 20 % PEG 8000

Table 2: Contd.,		
T_7 – 75 % Coconut water	T_8 - 2% Pulse sprout extract	T_9 - 0.5 % Nutrigold
V_1 – AC 35024	V_2 – AC 39021	V_3 - Gangavati Sona
V_4 - Jaya	V_5 – PS 267	V_6 – AC 39004

CONCLUSIONS

The rice seeds primed with 4 % *P. fluorescens* for 12 hours was found to be the best pre-sowing treatment for improving the seed germination and seedling vigour. The similar level of seedling growth enhancement was produced by seed treatment with 20 % *Azospirillum* sp, 2% Pulse sprout extract and 0.5 % Nutrigold for 12 h. In general, genotypes having high longevity nature showed increased seed germination and vigour compared to genotypes with low longevity after seed priming.

REFERENCES

1. *Abdul-baki, A.A. & Anderson, J.D. (1973). Vigour determination of soybean seeds by multiple criteria. Crop Sci. 13: 630-633.*
2. *Bernier, J., Atlin, G.N., Serraj, R., Kumar, A., & Spaner, D. (2008). Breeding upland rice for drought resistance. J. Sci. Food Agric., 88:927–939.*
3. *Elkheir, H.A., Yunus, M., Muslimin, M., Rinaldi Sjahril, Nurlina Kasim & Muhammad Riadi. (2016). Seed germination behaviors of some aerobic rice cultivars (Oryza sativa L.) after priming with polyethylene glycol-8000 (PEG-8000). International Journal of Scientific & Technology Research. 5(2): 227-234.*
4. *Farooq, M., Barsa, S.M.A. & Wahid, A. (2006). Priming of field-sown rice seed enhances germination, seedling establishment, allometry and yield. Plant Growth Regul. 49(2):285–294.*
5. *Halmer, P. (2003). Methods to improve seed performance.* ***In:*** *Benech-Arnold, R.L. & Sanchez, R.A. (Eds.) Seed physiology - applications to agriculture. Food Product Press, New York.*
6. *Harman, G.E., Taylor, A.G. & Stasz, T.E. (1989). Combining effective strains of Trichoderma harzianum and solid matrix priming to improve biological seed treatment. Phytopathology 73: 631-637.*
7. *ISTA. (2007). International Rules for Seed Testing. International Seed Testing Association, Switzerland.*
8. *Jayanthi, M. (2008). Organic fortification of seed and seed crop of rice with pulse sprout extract (Oryza sativa L.). Tamil Nadu Agricultural University, Coimbatire (M.Sc. Thesis)*
9. *Jisha, K.C. & Puthur, J.T. (2014). Seed halopriming outdo hydropriming in enhancing seedling vigor and osmotic stress tolerance potential of rice varieties. .J. Crop Sci. Biotechnol. 17: 209-219.*
10. *Karnwal, A. & Kaushik, P. (2011). Cytokinin production by fluorescent Pseudomonas in the presence of rice root exudates. Arch Phytopathology Plant Protect 44:1728-1735*
11. *Kokila, M. 2015. Physiological, biochemical and molecular basis of seed biopriming with biocontrol agents and liquid biofertilizers in rice hybrid CORH4 and its parental lines. Tamil Nadu Agricultural University, Coimbatore. 2015 (Doctoral Thesis).*
12. *Li, J., Zhang, H., Wang, D., Tang, B., Chen, C., Zhang, D., Zhang, M., Duan, J., Xiong, H., & Li, Z., (2011). Rice omics and biotechnology in China. Plant Omics. 4(6): 302-317.*

13. *Li, Z.K., Xu, J.L. (2007). Breeding for drought and salt-tolerant rice (Oryza sativa L.): progress and perspectives.* ***In:*** *Jenks MA, Hasegawa PM, Jain SM, (Eds.). Advances in molecular breeding toward drought and salt tolerant crops. The Netherlands: Springer 531–564.*
14. *Mc Donald M.B. (2000). Seed Priming.* ***In:*** *Seed technology and its biological basis, Black, M. and J.D. Bewley (Eds.). Sheffield Academic Press, Sheffield, UK.: 287-325.*
15. *Moeinzadeh, A., Sharif-Zadeh, F., Ahmadzadeh, M., & Heidari Tajabadi, F. (2010). Biopriming of sunflower (Helianthus annuus L.) seed with Pseudomonas fluorescens for improvement of seed invigoration and seedling growth. Australian Journal of Crop Science. 4(7): 564-570.*
16. *Nascimento. W.M. & Pereira, R.S. (2007). Preventing thermo-inhibition in carrot by seed priming. Seed Sci. Technol., 35: 504-507.*
17. *Panse, V.G. & Sukhatme, P.V. (1985). Statistical methods for agricultural workers, Indian Council of Agricultural Research, New Delhi.*
18. *Ramamoorthy, V., Viswanathan, R., Raghuchander, T., Prakasam, V. & Samiyappan, R., (2001). Induction of systemic resistance by plant growth promoting rhizobacteria in crop plants against pests and diseases. Crop Protection. 20: 1–11.*
19. *Salamone, G.I.E., Hynes, R.K. & Nelson, L.M. (2001). Cytokinnin production by plant growth promoting rhizobacteria and selected mutants. Canadian Journal of Microbiology. 47: 404-411.*
20. *Vijayan, R. (2005). Organic seed production in rice cv. ADT 43. Tamil Nadu Agricultural University, Coimbatore. (Doctoral Thesis).*
21. *Windham, M.T., Elad, Y. & Baker, R. (1986). A mechanism for increased plant growth induced by Trichoderma spp. Phytopathology. 76:518–521*