



Effect of seed coating with Hoagland solution on seed quality and field performance in rice (*Oryza sativa*)

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ABSTRACT

Field experiment was conducted at Directorate of Seed Research, Mau for three consecutive years (2007-08 to 2010-11) with the seed priming of one year old two rice (*Oryza sativa* L.) varieties (Pusa Sugandha 5 and Sambha Mahsoori) with 0.25% KNO₃ followed by coating with polykote (@3 ml/kg seed) + complete Hoagland solution (@5ml/kg seed) and polykote + (-) Zn, (-) Fe, (-) Mn and (-) Cu Hoagland solutions separately. Priming with KNO₃ salt followed by coating with polykote + complete Hoagland solution significantly enhanced the germination, seedling vigour and yield attributes in both the varieties over unprimed and uncoated control under salt stress condition. Variety Sambha Mahsoori was found superior over Pusa Sugandh 5 in respect of above characters.

Key words: Growth, Hoagland solution, KNO₃, Polykote, Rice, Seed priming, Seed coating, Yield

Rice (*Oryza sativa* L.) is the principal food crop of the world after wheat and one of the main staple food crops in India. It has the wider range of adoptability under different environments and mostly grown in lowlands under full irrigation or rainfed conditions. Water-deficit/excess, high salinity/alkalinity and other unfavorable environmental conditions adversely affect different physiological processes and nutrient availability resulting in poor germination, weaker seedlings and subsequently improper crop growth and poor crop yield in rice (Munns *et al.* 2006 and Farooq *et al.* 2012).

Seed enhancement techniques facilitates to apply various kinds of ingredients (inorganic salts, plant growth regulators, fungicides, insecticides, bio-agents and natural fillers) to the seeds either by soaking in solutions or by coating over seed surface using an adhesive chemically inert material. Use of these seed enhancement techniques ultimately enhances the seed germination, seedling vigour, nutrient availability and protects the crop from pest damage thereby improve crop growth and productivity and may be utilized to overcome such biotic and abiotic stresses in rice crop. Seed priming is one of the important part of enhancement techniques that induces rapid and vigorous seedling, early flowering and maturity of crop than dry seed (Musa *et al.* 2001) and also enable the crop to give higher yields under moisture stress conditions (Ceasay

2004, Hassanein *et al.* 2012). Applying nutrients through seed coating is new option for crop nourishment at the time of sowing/planting especially under salt affected soil where the nutrient availability is pH dependent which in turn regulate the overall growth and development of crop (Stendahl 2005, Scott 1989). Hoagland solution is a hydroponic nutrient solution which consists of necessary macro and micronutrients dissolved in water and used frequently in several crops for feeding nutrients. In the present investigation, simultaneous approach of seed priming with KNO₃ followed by seed coating using complete and deficient Hoagland solutions have been used to study its response in improving seed quality, growth and yield in rice.

MATERIALS AND METHODS

Quality seeds are the basis of agriculture and these determine the germination, vigour and overall crop stands which ultimately decide the yield parameters and yield of crop. In the present investigation, an effort was made to improve the seed quality through seed enhancement techniques including seed priming and seed coating. The field experiments were conducted during *kharif* seasons at the research farm of Directorate of Seed Research, Kushmaur, Mau for three consecutive years (2007-08 to 2010-11). The experiments were initiated with one year old rice seeds of two varieties (Pusa Sugandha 5 and Sambha Mahsoori) and seeds were primed with 0.25% KNO₃ for 12 hr. After shade drying, seeds were coated as per combination given as follows: T₀, Seeds with no priming and coating-Control; T₁, Seeds primed with 0.25% KNO₃,

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T₂, Seeds primed with 0.25% KNO₃ + Coated with Polykote @3ml/kg seed; T₃, Seeds primed with 0.25% KNO₃ + Coated with Polykote@3ml/kg seed + Complete Hoagland solution @5ml/kg seed; T₄, Seeds primed with 0.25% KNO₃ + Coated with Polykote@3ml/kg seed + (-) Zn Hoagland solution@5ml/kg seed; T₅, Seeds primed with 0.25% KNO₃ + Coated with Polykote@3ml/kg seed + (-) Fe Hoagland solution@5ml/kg seed; T₆, Seeds primed with 0.25% KNO₃ + Coated with Polykote@3ml/kg seed + (-) Mn Hoagland solution@5ml/kg seed; T₇, Seeds primed with 0.25% KNO₃ + Coated with Polykote@3ml/kg seed + (-) Cu Hoagland solution @ 5ml/kg seed.

Hoagland solutions were prepared following the procedures given by Hoagland and Arnon (1950). Nursery of all the treatments was raised following recommended cultural practices and 21 days, old seedlings were transplanted. The field experiment was conducted in a randomized block design with three replications. Seed quality parameters, viz. germination (ISTA 1999) and seedling vigour (Abdul-Baki and Anderson 1973) for each treatment were recorded. Observations were also recorded on panicle length, seeds/panicle, test weight, biological yield and grain yield. The experimental data recorded were pooled and statistically analyzed following the method of Panse and Sukhatme (1985).

Seed priming in rice seeds with KNO₃ (0.25%) for 12

hr significantly improved the germination, seedling dry weight and vigour index II over unprimed control in both the varieties evaluated seed coating with polykote along with complete Hoagland solution, further improved significantly seed quality parameters over primed and primed and coated with polykote alone in both the varieties indicated there by the role of Hoagland solution through seed coating on the improvement of seed quality parameters, the improvement in seed germination was 9, 6.5, 19, 11, 16, 14.6 and 16 per cent in T₁, T₂, T₃, T₄, T₅, T₆ and T₇ respectively, whereas per cent improvement in vigour was 17.2, 15, 61.2, 40.2, 47.6, 48.3 and 48.7 in T₁, T₂, T₃, T₄, T₅, T₆ and T₇ respectively over untreated control (Table 1). Improvement in seed quality parameters through seed priming with inorganic salt like KNO₃ has also been reported by several workers including Bose (1997), Bose *et al.* (2000), Pandita *et al.* (2003), Bose *et al.* (2003) and Pandey *et al.* (2006) but the role of Hoagland solution in improving seed quality might be due to complete nourishment of newly emerging seedling by complete nutrient solution that have provided accelerating force for activation of several hydrolytic enzymes responsible for germination and served as precursor of gibberellic acid synthesis which is the key hormone for initiation of germination and growth of seedling.

Similarly the growth parameter like tillers/hill was also

Table 1 Effects of seed priming and coating on seed quality in rice (Pooled estimate of three years)

Treatment	Germination (%)			Seedling dry wt (g)			Vigour index		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean
T ₀ - Seeds with No priming and No coating-Control	72.33 (58.26)	76.67 (61.12)	74.5 (59.69)	1.43	1.41	1.42	103.44	108.12	105.70
T ₁ -Seeds primed with 0.25% KNO ₃	77.77 (61.87)	84.67 (67.12)	81.22 (64.49)	1.49	1.56	1.52	115.88	132.09	123.90
T ₂ - Seeds primed with 0.25% KNO ₃ + coated with Polykote @3ml/kg seed	76.67 (61.14)	82.11 (65.02)	79.39 (63.08)	1.50	1.56	1.53	115.01	128.09	121.55
T ₃ - Seeds primed with 0.25% KNO ₃ + Polykote@3ml/kg seed + complete Hoagland solution @5ml/kg seed	85.89 (67.93)	91.66 (73.33)	88.77 (47.08)	1.93	1.91	1.92	165.77	175.08	170.42
T ₄ - Seeds primed with 0.25% KNO ₃ + Polykote @3ml/kg seed + (-) Zn Hoagland solution@5ml/kg seed	80.44 (63.75)	85.11 (67.31)	82.77 (43.69)	1.77	1.81	1.79	142.38	154.05	148.21
T ₅ - Seeds primed with 0.25% KNO ₃ + Polykote @3ml/kg seed + (-) Fe Hoagland solution@5ml/kg seed	83.08 (65.75)	90.00 (71.56)	86.5 (68.65)	1.86	1.75	1.80	154.53	157.5	156.01
T ₆ - Seeds primed with 0.25% KNO ₃ + Polykote @3ml/kg seed + (-) Mn Hoagland solution@5ml/kg seed	83.33 (65.90)	87.55 (69.34)	85.44 (67.62)	1.85	1.82	1.83	154.17	159.35	156.76
Mean	80.36 (63.82)	85.92 (68.24)		1.71	1.69		138.48	146.48	1.71
	SE±	CD		SE±	CD		SE±	CD	
Variety (V)	0.41	0.843		0.010	0.021				
Treatment (T)	0.82	1.687		0.020	0.043				
VT	1.16	2.385		0.029	0.060				

CD significant at P ≤ 0.05 level; Values in parenthesis are transformed values

Table 2 Effects of seed priming and coating on yield attributing and yield in rice (Pooled estimate of three years)

Treatment	Tillers/hill			Panicles length(cm)			Seeds/panicle			Test weight (g)			Biological yield (kg)			Grain yield/plot (kg)		
	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean	V ₁	V ₂	Mean
T ₀ - Seed with No priming and No coating-Control	8.48	12.96	10.72	25.99	21.48	23.73	96.37	165.07	130.72	30.37	25.35	27.86	12.67	16.16	14.41	5.18	6.08	5.63
T ₁ -Seeds primed with 0.25% KNO ₃	9.69	12.81	11.25	27.06	20.64	23.85	98.74	155.61	127.17	30.47	27.10	28.78	13.18	17.17	15.17	5.61	6.83	6.22
T ₂ - Seeds primed with 0.25% KNO ₃ + coated with Polykote @3ml/kg seed	9.33	12.67	11	26.68	21.11	23.89	102.16	179.33	140.74	30.30	27.00	28.65	12.80	17.03	14.91	5.20	6.37	5.78
T ₃ - Seeds primed with 0.25% KNO ₃ +Polykote @3ml/kg seed+complete Hoagland solution @5ml/kg seed	10.59	15.01	12.8	28.71	19.37	24.04	98.99	192.96	145.97	30.66	27.90	29.28	13.04	20.95	16.99	6.16	7.67	6.91
T ₄ - Seeds primed with 0.25% KNO ₃ +Polykote @3ml/kg seed+ (-) Zn Hoagland solution @5ml/kg seed	9.33	13.33	11.33	26.65	20.69	23.67	95.55	169.01	132.28	30.43	27.16	28.79	13.03	18.78	15.90	5.90	7.34	6.62
T ₅ - Seeds primed with 0.25% KNO ₃ +Polykote @3ml/kg seed + (-) Fe Hoagland solution @5ml/kg seed	9.63	14.84	12.23	26.67	20.88	23.77	90.77	180.54	135.65	30.19	27.15	28.67	13.63	17.99	15.81	6.10	7.44	6.77
T ₆ - Seeds primed with 0.25% KNO ₃ +Polykote @3ml/kg seed+ (-) Mn Hoagland solution @5ml/kg seed	9.55	14.25	11.9	26.76	20.99	23.87	102.10	173.83	137.96	30.42	27.17	28.79	12.90	18.87	15.88	6.07	7.55	6.81
T ₇ - Seeds primed with 0.25% KNO ₃ +Polykote @3ml/kg seed + (-) Cu Hoagland solution @ 5ml/kg seed	10.23	13.54	11.88	24.68	20.56	22.62	90.34	164.95	127.64	30.24	27.28	28.76	13.48	18.96	16.22	6.15	7.65	6.90
Mean	9.61	13.68		26.65	20.72		96.88	172.67		30.38	27.01		13.09	18.24		5.79	7.12	30.38
Variety (V)	SE±	CD		SE±	CD		SE±	CD		SE±	CD		SE±	CD		SE±	CD	
Treatment (T)	0.21	0.432		0.329	0.673		3.992	8.154		0.396	0.810		0.166	0.339		0.132	0.271	
VT	0.42	0.865		0.659	NS		7.985	NS		0.793	1.620		0.332	0.679		0.265	0.542	
	0.59	1.224		0.932	NS		11.292	NS		1.122	2.291		0.470	0.961		0.375	0.766	

CD significant at P ≤ 0.05 level

influenced very much with seed priming followed by seed coating with complete Hoagland solution and produced maximum number of tillers (12.80/hill). The response of seed priming/seed coating alone was not significant over unprimed/uncoated control. When the coating of seed was done with deficient Hoagland solution the number of tillers was reduced as compared to seed coated with complete Hoagland solution. However, reduction in tiller number was maximum with Zn deficient, hoagland solution followed by others indicated there by the role of zinc in tiller production in rice because of its role as precursor in growth hormone synthesis (Table 2). Interaction of V × T was also significant and maximum tillers was noted with V₂ (Sambha mahsoori) in T₄. Varieties significantly differed in tillers and V₂ (13.67) showed significantly higher mean number of tillers over V₁.

In yield components, panicles length and number of seeds/panicle were not affected significantly with any of the seed enhancement treatments applied including seed priming (0.25% KNO₃) and seed coating (Polykote alone or in combination of complete/deficient Hoagland solution). However, the differences in these characters at varietal level were significant. Variety Pusa Sugandha 5 showed higher panicle length whereas number of grain/panicle was higher in Sambha Mahsoori. The interactions of V × T were also non-significant in these characters (Table 2).

In 1 000 grain weight, the improvement was noticed with different seed enhancement treatments and it was maximum with seed primed with KNO₃ (0.25%) followed by seed coating with complete Hoagland solution (T₃) in both the varieties evaluated but statistically it was non-significant over control. Variety PS 5 showed more 1 000 grain weight than Sambha Mahsoori but the per cent of improvement in test weight in response to these treatments was higher in Sambha Mahsoori in comparison to PS 5.

Biological yield and grain yield were significantly enhanced through seed priming with KNO₃ (0.25%) over unprimed and uncoated control in both the varieties evaluated. The per cent improvement in test weight was 3.3, 2.8, 5, 3.3, 2.9, 3.3, 3.2 and in biological yield it was 5.2, 3.5, 17.9, 10.3, 9.7, 10.2, 12.5 respectively in T₁, T₂, T₃, T₄, T₅, T₆ and T₇ over control. However, these characters were further improved significantly over priming treatment when the seeds were coated with complete or deficient Hoagland solution. The enhancement in yield over control was registered 10.48, 2.75, 22.82, 17.58, 20.25, 20.96, 22.56 per cent and recorded maximum biological yield and grain yield in T₃ treatment (seeds primed with 0.25% KNO₃ and coated with complete Hoagland solution along with polykote). However the role of polykote alone was negligible. Among the varieties, Sambha Mahsoori produced significantly higher biological as well grain yield over PS 5. In the deficient hoagland solutions, Zinc deficient solution showed maximum reduction over complete hoagland solution followed by iron, manganese and copper deficient solutions in almost all the characters studied indicating thereby the role of zinc and other micronutrients in rice

crop growth and productivity (Table 2). Our findings are supported by Farooq *et al.* (2012) who reported that micronutrient seed treatments, which include seed coating also improves the stand establishment, advances phenological events, and increases yield and micronutrient grain contents in a number of field crops. They also pointed out that micronutrient application through seed treatment performed better or similar to other application methods. Being an easy and cost effective method of micronutrient application, seed treatments offer an attractive option for resource-poor farmers.

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