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Effect of Seed Priming on Yield Attributes and Grain Quality of Rice under timely and Late Sown conditions

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In the present investigation rice genotype HUR-105 was selected to see the effect of seed priming on yield attributes and grain quality of rice. Priming of seeds has been done with distilled water (hydro), $Mg(NO_3)_2$ salt (halo) and kinetin (T_3), salicylic acid (hormonal) and different parameters, such as grains panicle^{-1}, test weight, harvest index, panicle number hill^{-1}, panicle length and amylose content were studied at different study periods with respect to two sowing conditions, representing timely and late sowing of rice crop. Priming of seeds was found to improve yield attributes and grain quality parameters over non-primed (control) set in timely as well as in late sown conditions. The work therefore presents the late sown stress ameliorating role of seed priming in rice genotypes.

Introduction

In advent of changing climatic conditions plants faces deleterious affect of abiotic (heat, cold, drought and salt) and biotic stress during their life cycle. These abiotic and biotic stresses are often interrelated and cause undesirable morphological, physiological, biochemical and molecular changes that affect plant growth and development and ultimately yield. Sowing time is very important for a crop to get its maximum yield and delaying in sowing time may cause significantly reduction in crop growth and yield. Seed is the prime input in agriculture sector and production of quality seed is the immense challenge in agriculture to combat the issue of global food security. Approaches in modern plant breeding and molecular techniques and tools are needed to combat abiotic and biotic stresses. However, alternatively, some simple and economical techniques are also in race to address this issue. Seed priming is one of them, approved by many agriculturists for better crop stand establishment and growth, even under adverse environmental conditions.

Rapid germination and emergence is an important determinant of successful establishment (Heydecker *et al.*, 1973, 1975; Bose and Mishra 1997; Bose *et al.*, 2007; Kumar et al.2016). Harris *et al.,* (1999) reported seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions. Seed priming has presented promising, and even surprising results, for many crop seeds (Bradford, 1986).

Bose and her research group did a number of works in respect to seed priming of various field crops like maize, wheat, mustard, rice and okra. They developed that pre-sowing soaking or hardening (hydration and dehydration of seeds) of seeds with various salts containing nitrate can improve a number of physiological, morphological and biochemical process in each and every phase of plant's life and finally the yield. They observed that nitrate seed hardening treatment induce nitrate reductase activity, nitrogen utilizing efficiency, antioxidant metabolism and yield attributes in various field crops (Bose *et al.,* 1992). They also established that sowing time is very important for a crop to get its maximum yield potential which can be maintained by nitrate seed treatment during late of sowing of wheat and mustard (Bose and Mishra, 1999).

Materials and Methods

In the present experiment, rice variety HUR-105 was selected for experimental purpose. Healthy seeds were surface sterilized with0.01% $HgCl_2$ (Mercuric chloride) solution for 5 minutes and then thoroughly washed with distilled water for 5-6 times. Three priming treatments were used for this experiment that include hydropriming(T_1) (using distilled water), halopriming and hormonal priming using 5 mM/ppm concentration of $Mg(NO_3)_2$ (T_2), Kinetin (T_3) and 0.75 mM concentration of salicylic acid(T_4) for 18 h with a set of non primed (T_0;control) seeds. After 18 h these seeds were air dried to bring back to its original moisture content and finally, the seeds were kept in paper packets and used within one month. Sowing of seeds was done at two different conditions i.e. timely (recommended) and late (20 Days delay after recommended sowing). Experiments were conducted in Factorial Randomized Block Design (RBD) during 2015 and 2016 at Agricultural Research Farm, Banaras Hindu University, Varanasi.

Grains panicle^{-1}

The number of grains panicle^{-1} were counted manually.

Test weight

For recording test weight, one thousand grains were selected from each experimental plot randomly and then the weight was taken on electronic balance.

Harvest index (%)

The harvest index (HI) (Donald 1962) was calculated by dividing the economic (grain) yield to the total biological yield (straw + yield) and then multiplied with 100.

Panicle number hill^{-1}

For the counting panicle number, three hills were selected randomly from each treatment/plot and panicle number counted hill^{-1} manually.

Panicle length

Panicle length was recorded in centimetre with the help of scale, for this length was measured from the neck node to the end of the panicle.

Amylose content

To 100 mg of rice flour 1 ml of 95% ethanol and 9 ml of 1.0 N NaOH was added. This was mixed well and heated in a boiling water-bath for 10 min. Samples were diluted to 100 ml with distilled water. From this suspension, 5 ml of sample was taken and 1 ml of acetic acid (57.75 ml in one liter water) was added to acidify the sample along with 1.5 ml of iodine solution (0.2% iodine + 2% potassium iodide) and the volume was made to 100 ml with distilled water. The samples were incubated at room temperature for 20 min. The absorbance was measured at 620 nm using spectrophotometer. As a control, NaOH solution was used. The amylose content of different varieties was calculated in comparison with standard graph (Perez and Juliano, 1978).

Statistical analysis

Mean values were taken from each treatment of three independent replications. Analysis of variance was performed by using SPSS version 16.0 software. Duncan's test was used to determine significant difference among treatments

Results and Discussion

Table 1 represents grains panicle^{-1} of rice var. HUR-105 under timely and late sown conditions. Data predicted that late sown condition causes reduction in grains panicle^{-1} but priming treatments were found to increase the grains panicle^{-1} over the non primed control set and maximum grains panicle^{-1} were noted in $Mg(NO_3)_2$ primed set (T_2) followed by T_3 and T_1 under timely as well as late sown conditions. Whereas, non primed and T_4 sets showed poor performance. The same trend was followed in both studied years.

Study regarding test weight of rice var. HUR-105(Table 2.) showed that test weight of rice crop was found to decrease under late sown condition. However primed sets were found to improve test weight under timely as well as late sown conditions and treatment T_2 showed maximum test weight followed by T_1.Whereas T_0 and T_4 observed poor performance. The same trend followed in both studied years.

Table 3 represents harvest index (HI %) of rice var. HUR-105, obtained from primed and non primed seeds. Reduction in harvest index was noted under late sown condition but primed sets have more harvest index than non primed set under both sowing conditions and maximum HI% was noted in T_2 set. Non primed set always showed poor performance. Same trend followed in both studied years.

Table 4 has depicted the data regarding panicle number hill^{-1} obtained from primed and non primed seeds of rice. Panicle number hill^{-1} was found to increase in primed set over non primed control set in both sowing conditions but reduction in panicle number was noted under late sown condition. Kinetin (T_3) primed set sowed best result between primed sets. Same trend followed in both studied years.

Table 5 represents data regarding panicle length of rice, obtained from primed and non primed sets. Panicle length was found to reduce under late sown condition. Tillers grown from primed sets have more panicle length over non primed set and maximum panicle length was noted in T_3 set. The same trend followed in both studied years.

Study regarding amylose content in rice grain (Table 6.) showed that primed set have more amylose content over non primed control set and maximum amylose content was noted in T_3 set. However reduction in amylaoe content was found under late sown condition. The trend was found similar for both the experimental years.

Table.1 Effect of hydro, halo and hormonal seed priming on grains panicle^{-1} of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	Grains Panicle^{-1}
2015	I*	T_0	163.33±4.34^{f,g}
		T_1	186.33±1.86^{e}
		T_2	190.67±3.29^{e}
		T_3	187.33±1.45^{e}
		T4	168.00±2.52^{f}
	II**	T_0	158.00±1.16^{g}
		T_1	182.67±1.45^{e}
		T_2	187.33±1.45^{e}
		T_3	186.33±6.77^{e}
		T4	169.00±1.73^{f}
2016	I*	T_0	169.00±1.67^{l}
		T_1	189.00±1.53^{j}
		T_2	215.00±0.58^{g}
		T_3	208.33±0.58^{h}
		T4	172.33±0.88^{k,l}
	II**	T_0	174.33±0.83^{k}
		T_1	188.33±0.88^{j}
		T_2	193.67±2.61^{i}
		T_3	190.33±0.67^{i,j}
		T4	171.00±1.53^{k,l}

Data presented are means from three replicates with standard errors. Within each treatment, different letters indicate significant differences by Duncan's multiple range test at $P<0.05$

*****Timely sown; **Late sown; *** T_0: Non primed control; T_1: Hydro primed; T_2: $Mg(NO_3)_2$; T_3: Kinetin and T_4: Salicylic acid

Table.2 Effect of hydro, halo and hormonal seed priming on the test weight of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	Test weight(g)
2015	I*	T_0	21.82±0.03^{p}
		T_1	23.69±0.02^{j}
		T_2	23.81±0.01^{i}
		T_3	22.80±0.02^{m}
		T4	22.51±0.01^{n}
	II**	T_0	21.19±0.03^{q}
		T_1	23.29±0.02^{l}
		T_2	23.68±0.02^{j}
		T_3	22.18±0.04^{o}
		T4	21.77±0.01^{p}
2016	I*	T_0	22.40±0.03^{n}
		T_1	23.69±0.02^{j}
		T_2	23.92±0.02^{i}
		T_3	22.79±0.03^{m}
		T4	23.20±0.02^{k}
	II**	T_0	21.29±0.02^{q}
		T_1	21.72±0.01^{o}
		T_2	22.79±0.02^{m}
		T_3	22.92±0.03^{l}
		T4	21.60±0.03^{p}

Note: Detail of the conditions has given in table 1.

Table.3 Effect of hydro, halo and hormonal seed priming on the harvest index (HI%) of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	HI% Harvest index
2015	**I***	T_0	45.54±4.62[a,b,c,d]
		T_1	46.55±1.73[a,b,c]
		T_2	49.11±1.18[a,b]
		T_3	48.50±2.87[a,b,C]
		T4	46.51±1.73[a,b,C]
	II**	T_0	44.36±0.58[a,b,c]
		T_1	44.61±1.79[a,b,c]
		T_2	48.15±2.89[a,b]
		T_3	46.50±1.16[a,b]
		T4	45.00±1.73[a,b]
2016	**I***	T_0	45.52±1.16[a,b,c]
		T_1	46.12±1.76[a,b]
		T_2	48.47±1.18[a,b]
		T_3	46.91±0.58[a,b]
		T4	46.05±1.78[a,b,c]
	II**	T_0	46.66±0.71[a,b,c]
		T_1	46.87±1.73[a,b,c]
		T_2	48.90±1.18[a,b]
		T_3	47.58±1.19[a,b]
		T4	47.39±1.73[a,b,c]

Note: Detail of the conditions has given in table 1.

Table.4 Effect of hydro, halo and hormonal seed priming on the panicle number hill^{-1} of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	Panicle no. hill^{-1}
2015	**I***	T_0	7.00±0.58[a,b,c,d]
		T_1	9.00±0.00[b,c,d]
		T_2	9.33±0.33[a,b,c]
		T_3	9.67±0.33[a,b]
		T4	9.00±0.58[a,b,c,d]
	II**	T_0	7.67±0.88[b,c,d]
		T_1	9.33±0.33[a,b,c]
		T_2	9.33±0.67[a,b,c]
		T_3	9.67±0.33[a,b]
		T4	9.00±0.58[a,b,c,d]
2016	**I***	T_0	8.00±0.58[a,b]
		T_1	9.00±0.58[a,b]
		T_2	9.33±0.33a
		T_3	10.00±0.5[a]
		T4	9.33±0.67[a,b]
	II**	T_0	8.33±0.33[a]
		T_1	9.00±0.58[a]
		T_2	9.67±0.33[a]
		T_3	10.00±0.00[a]
		T4	8.33±0.88[a,b]

Note: Detail of the conditions has given in table 1.

Table.5 Effect of hydro, halo and hormonal seed priming on the panicle length of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	Panicle length (cm)
2015	I*	T_0	23.33±0.11[d]
		T_1	24.05±0.18[d]
		T_2	24.32±0.05[d]
		T_3	24.57±0.88[c,d]
		T4	24.17±0.17[d]
	II**	T_0	24.17±0.00[d]
		T_1	24.00±0.04[d]
		T_2	24.37±0.05[d]
		T_3	24.56±0.17[c,d]
		T4	24.31±0.03[d]
2016	I*	T_0	21.67±0.50[d]
		T_1	22.00±0.58[a,b]
		T_2	23.00±0.56[a,b,c]
		T_3	25.50±0.35[a,b]
		T4	22.67±0.67[a,b,c,d]
	II**	T_0	20.33±0.38[b,c,d]
		T_1	21.67±0.33[a,b,c,d]
		T_2	21.67±0.84[a]
		T_3	22.33±0.39[a,b,c]
		T4	22.00±1.53[a,b,c,d]

Note: Detail of the conditions has given in table 1.

Table.6 Effect of hydro, halo and hormonal seed priming on the amylose content of rice (Var. HUR 105) under timely and late sown conditions

Year	Sowing Time	Treatments***	Amylose content (%)
2015	I*	T_0	22.67±0.10[f]
		T_1	23.30±0.09[e]
		T_2	23.37±0.03[e]
		T_3	23.54±0.05[d,e]
		T4	23.29±0.06[e]
	II**	T_0	22.53±0.18[f]
		T_1	23.54±0.04[d,e]
		T_2	23.78±0.03[d]
		T_3	23.76±0.06[d]
		T4	23.61±0.04[d,e]
2016	I*	T_0	22.54±0.04[e]
		T_1	23.41±0.07[d]
		T_2	23.44±0.05[c,d]
		T_3	23.69±0.09[c,d]
		T4	23.39±0.04[d]
	II**	T_0	22.61±0.11[e]
		T_1	23.65±0.21[c,d]
		T_2	23.62±0.19[c,d]
		T_3	23.79±0.07[e]
		T4	23.57±0.20[c,d]

Note: Detail of the conditions has given in table 1.

Study regarding grains panicle^{-1}, test weight, harvest index, panicle number hill^{-1}, panicle length and amylose content of rice var. HUR 105 under timely and late sown conditions predicted that grain number panicle^{-1} was increased in primed sets over non primed sets under both studied conditions. Reduction in grains panicle^{-1} was noted under late sown condition. It may be due to reduction in vegetative growth period resulting less photosynthase accumulation that may be related with reduction in grain number. Nitrate seed hardening induce nitrate reductase activity, nitrogen utilizing efficiency, antioxidant metabolism and yield attributes in various field crops (Bose *et al.*, 1992). They also established that sowing time is very important for a crop to get its maximum yield potential which can be maintained by nitrate seed treatment during late sowing of wheat and mustard (Bose and Mishra, 1999).In case of wheat it has been observed by Farook *et al.*, (2008) that seed priming treatment is able to overcome the bad effect of late sowing of this crop. The $Mg(NO_3)_2$ primed seeds of rice varieties showed improvement in the growth, induced antioxidant defence metabolism and yield attributes in respect to control in normal condition (Srivastava and Bose 2012). Similar result was noted and reported in wheat by Siddique and bose (2015). Similar result was reported by Farooq *et al.*, 2006.

The present study concludes that priming of seeds with magnesium salt and hormones can overcome the negative effect of delay sowing and able to improve the yield and grain quality.

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