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Role of seed priming on biochemical changes and NPK uptake of rice (*Oryza* sativa L.)

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Abstract
The present investigation entitled "Role of seed priming on biochemical changes and NPK uptake of rice (*Oryza sativa* L.)'' was carried out in *kharif* season, during 2014 at the student instructions farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) India. The experiment was laid down in randomized block design with three replications on rice. The seed priming treatments were comprised of priming with 5 chemicals at 1% concentration *viz* (KNO_3, KH_2PO_4, $Ca(NO_3)_2$, KCl and $Na_2S_2O_3$) along with untreated control and hydro- priming. Seed priming was done for 24 hours. Observations were recorded at 20, 40, 60 and 80 DAT. The observations were taken on biochemical changes like Chlorophyll content and Catalase activity in leaf while NPK uptake was recorded in plants at maturity. All the Chemicals (KNO_3, KH_2PO_4 $Ca(NO_3)_2$, KCl and $Na_2S_2O_3$) influenced biochemical changes and NPK uptake positively however, the effect of KH_2PO_4 @ 1% was found most effective and significantly increased chlorophyll content, catalase activity and NPK uptake.

Keywords: Rice, Chlorophyll, Catalase, Seed priming, NPK uptak

Introduction
Rice (*Oryza sativa* L.) belongs to family poaceae. It is a most important cereal crop of *kharif* season. It is a major source of food of more than half of global population. Its cultivation is immense important of food security of Asia where more than 90% of the world rice grown and consumed. Rice is the most important cereal food crop of India. It occupies about 23.3% of gross cropped area of the country and plays vital role in the national food grain supply. Rice contributes 43% of total food grain production and 46% of the total cereal production of the country. It is the staple food of more than 60% of the world's population especially for most of the people of South-East Asia. Rice in India, although traditionally rainy season crop, and is also increasing in acreage in winter season in certain specific pockets. However, it is now grown in most of the parts of the country and is broadly classified as Aman, Aus and Boro depending on season of cultivation.

Seed are important and costly input in farming, rapid and uniform field emergence is two essential pre-requisites to increase yield, quality and ultimately profit of annual crops. Rate and uniformity of seedling emergence are key component of seed yield quality in both irrigated and rainfed environments. Slow emergence results in smaller plants and seedlings which are more vulnerable to soil-borne diseases. Various pre-sowing seed treatments have been used to reduce the time between seed sowing and seedling emergence and to improve synchronization of seedling emergence in field in all annual as well as perennial crops. Seed priming is a specific seed treatment given to seed before sowing especially in adverse soil moisture conditions and highly recommended and successful in rainfed agriculture.

Seed priming (osmoconditioning) is a technique that has proved effective for improving germination, seedling emergence and yield of many early planted, small seeded vegetables and flower crops. Priming or control hydration refers to conditioning of seeds in aerated solution with high solute content, which keeps the seed in a partially hydrated state (Chong *et al.* 2002) [2]. Seed priming is one of the method which results in modifying the physiological and biochemical nature of seeds so as to get the characters that are favorable for drought tolerance. It is also known as extensive physiological reorganization induced by hydration and dehydration processes. During priming process a number of physico-chemical changes occurs, modifying the protoplasmic characters and increasing physiological activity of the embryo

and associated structures. Eventually, this results in the absorption of more water due to increase in the elasticity of cell wall and development of a stronger and efficient root system.

Materials and Methods

The present investigation was carried out in *kharif* season, during 2014 on the student instructions farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) India. Plants received uniform cultural operation throughout the experimentation. Soil of the experimental site is normal in nature (pH 7.8) and the experiment was laid down in randomized block design with three replications. Bold and healthy seeds of rice variety NDR-359 were soaked in the solution of preparation of 1% KNO_3, KH_2PO_4, $Ca(NO_3)_2$, KCl, $Na_2S_2O_3$ and distilled water for hydro-priming, for 24 hours. After that seeds were taken out from the solution and distilled water and dried for one hour in shade. Primed seeds along with untreated seeds were sown in puddled beds to raise the nursery. N, P and K were applied at the rate of 80:40:40 $kgha^{-1}$ in the nursery. Full dose of P and K and $^3/_4$ of nitrogen were applied as basal and $^1/_4$ N was given on 14th days after seeding. At the time of field preparation, half dose of nitrogen and full dose of phosphorus and potash were applied @ 120:40:40kg. N P K in the form of urea, single super phosphate and murate of potash. The remaining half dose of nitrogen was applied at the time of tillering and panicle initiation stage. SPAD values were measured with the help of SPAD Model: X55/M-PEA. Catalase activity can be assayed colorimetrically according to method given in analytical biochemistry (Sinha, 1972) [2]. The nitrogen and phosphorus of straw and grain was determined separately using colorimetric method of Linder (1944) [3]. The Potassium of shoot and grain was determined separately using flame photometer.

Results and Discussions

It is clear from the data presented in Table 1 reveal that all the seed priming treatments significantly improved chlorophyll content in leaf at all the stages of observation in comparison to non-priming (control). The effect of KH_2PO_4 and $Na_2S_2O_3$ was more pronounced and produced significant effect on chlorophyll content at all the stages of the observation. Chlorophyllase enzyme which is responsible for chlorophyll degradation might have been inhibited by priming treatment. The Similar increase in chlorophyll content has been reported by EI-Tayed (2005) in barley and Bharti and Malik (2013) in mustard. Chlorophyll is known to influence the photosynthesis rate and in turn influence growth and development.

The data regarding catalase activity in leaf are presented in Table 2. It is evident from the data that catalase activities increase with the increase of crop age. All the seed priming treatments significantly increased catalase content in leaf at every stage of observation. The effect catalase activity was more pronounced in KH_2PO_4 followed by $Ca(NO_3)_2$, $Na_2S_2O_3$, KCl, KNO_3 and hydro-priming at each stage of observation. Rest of treatments produced significant effect only at 20 and 40 DAT. The priming strategies enhanced activities of free radical scavenging catalase (CAT) enzyme. Similar results were reported by Jieet *et al.* (2002) [4] in rye, Afzal *et al.* (2006) [1] and Zhang *et al.* (2005) [7].

The data presented in table 3 reveal that all the seed priming treatments significantly increased N uptake in rice grain in comparison to control. The maximum N uptake (69.19 kg ha^{-1}) was obtained in seed primed with KH_2PO_4, followed by $Ca(NO_3)_2$, $Na_2S_2O_3$, KCl, KNO_3 and hydropriming at each stage of observation. The nitrogen uptake data in straw are presented in table-8.1 reveal similar trend of nitrogen content as in case of grains. Nitrogen is the fourth most abundant element in plants following C, O and H. Nitrogen is a major structural constituent of the cell. It is an essential constituent of the different types of metabolically active compounds, like amino acids, proteins, nucleic acids, prophyrins, flavins, enzymes and co-enzymes. These findings are in confirmation of the earlier report of Thakuria and Sharma (1995) [6] in rice and Farooq *et al.* (2005) [3] in rice.

The data regarding phosphorus content of rice crop recorded at maturity are presented in Table 4. It is evident from the data that maximum P uptake in rice grain was found (14.59 kg ha^{-1}) in seed primed with the KH_2PO_4 which was significantly superior over the control (8.24 kg ha^{-1}) and followed by $Ca(NO_3)_2$ and $Na_2S_2O_3$,KCl, KNO_3 and hydropriming. Similar trend in phosphorus uptake was also recorded in rice straw (Table 4). Phosphorus is a structural component of the membrane systems of the cell and the mitochondria. It is essential constituent of nucleoproteins, organic molecules (ATP, ADP etc) which play an important role in the energy transfer reactions of cell metasbolism, nucleic acids, and coenzymes like NADP. These findings are in confirmation of the earlier report of Zhang *et al.* (1998) in maize and Shah *et al*. (2012) [5] in mungbean.

Data on K uptake in rice grain and straw are presented in Table 5. It is clear from the data that all the seed priming treatments significantly increased potassium in grains and straw and maximum increase was noted in KH_2PO_4 followed by, $Ca(NO_3)_2$, $Na_2S_2O_3$, KCl, KNO_3 hydropriming and non-primed (control). Potassium plays a significant role in stomatal opening and closing. The mechanism of stomatal closure and opening depends entirely on the K flux. It is also enhances the translocation of assimilates and promotes rate of CO_2 assimilation. Potassium is essential in activating some enzyme, involved in the synthesis of certain bonds and carbohydrates metabolism. It is known to maintain integrity of cell membranes. Seed priming enhanced K^+ concentration in lolium plant. These results are also confirmed with Thakuria and Sharma (1995) [6] in rice.

Table 1: Effect of seed priming treatments on chlorophyll content.

Treatment		Chlorophyll content (SPAD Value)			
		DAT			
		20	40	60	80
T_1	Non Priming (control)	3.74	5.23	8.4	7.47
T_2	Hydro Priming	4.89	6.25	9.24	7.71
T_3	Priming in KNO_3-1%	5.54	7.32	9.33	7.91
T_4	Priming in KH_2PO_4-1%	6.89	9.98	10.72	9.43
T_5	Priming in $Ca(NO_3)_2$ - 1%	6.40	8.96	10.14	8.69
T_6	Priming in KCl -1%	5.70	8.00	9.04	8.11
T_7	Priming in $Na_2S_2O_3$-1%	6.16	9.09	9.77	8.14
	SEm±	0.10	0.16	0.35	0.21
	CD at (5%)	0.30	0.49	1.08	0.66

Table 2: Effect of seed priming treatments on catalase activity

Treatment		Catalase activity (g^{-1}fresh wt. min^{-1})			
		DAT			
		20	40	60	80
T_1	Non Priming (control)	105.44	214.16	311.54	398.50
T_2	Hydro Priming	108.03	215.02	323.07	399.05
T_3	Priming in KNO_3-1%	151.68	233.47	324.33	400.46
T_4	Priming in KH_2PO_4-1%	198.00	296.07	391.86	413.37
T_5	Priming in $Ca(NO_3)_2$ - 1%	183.40	281.76	385.58	408.69
T_6	Priming in KCl -1%	165.05	260.44	359.92	404.68
T_7	Priming in $Na_2S_2O_3$-1%	178.97	265.62	387.24	405.96
	SEm±	2.42	11.35	15.12	2.52
	CD at (5%)	7.47	34.97	46.60	7.76

Table 3: Effect of seed priming treatments on nitrogen uptake

Treatment		Nitrogen uptake (kg ha^{-1})	
		In grains	In straw
T_1	Non Priming (control)	49.46	27.37
T_2	Hydro Priming	54.30	29.57
T_3	Priming in KNO_3-1%	57.95	30.24
T_4	Priming in KH_2PO_4-1%	69.19	35.92
T_5	Priming in $Ca(NO_3)_2$ - 1%	66.35	34.44
T_6	Priming in KCl -1%	59.52	31.31
T_7	Priming in $Na_2S_2O_3$-1%	62.70	33.07
	SEm±	0.52	0.27
	CD at (5%)	1.60	0.83

Table 4: Effect of seed priming treatments on phosphorus uptake

Treatment		Phosphorus Uptake (kg ha^{-1})	
		In grains	In straw
T_1	Non Priming (control)	8.24	5.57
T_2	Hydro Priming	9.68	6.86
T_3	Priming in KNO_3-1%	10.81	7.96
T_4	Priming in KH_2PO_4-1%	14.59	9.54
T_5	Priming in $Ca(NO_3)_2$ - 1%	12.99	8.88
T_6	Priming in KCl -1%	11.54	7.96
T_7	Priming in $Na_2S_2O_3$-1%	12.17	8.67
	SEm±	0.11	0.07
	CD at (5%)	**0.33**	**0.22**

Table 5: Effect of seed priming treatments on potassium uptake

Treatment		Potassium uptake (kg ha^{-1})	
		In grains	In straw
T_1	Non Priming (control)	21.82	56.36
T_2	Hydro Priming	23.49	58.84
T_3	Priming in KNO_3-1%	24.39	59.65
T_4	Priming in KH_2PO_4-1%	27.34	64.60
T_5	Priming in $Ca(NO_3)_2$ - 1%	26.86	63.78
T_6	Priming in KCl -1%	25.27	60.28
T_7	Priming in $Na_2S_2O_3$-1%	26.02	61.91
	SEm±	0.20	0.48
	CD at (5%)	0.62	1.49

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