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ORIGINAL ARTICLE

Effect of hydropriming and halopriming with different concentrations of some K and Mg-salts on safe limit, germination and early seedling growth of some wheat (*Triticum aestivum* L.) genotypes of Jharkhand.

***Sanjeeda Khatoon and Amar Singh**
Department of Botany, Jamshedpur Co-operative College, Jamshedpur, Jharkhand, India
*E-mail : sanjeedak84@gmail.com

ABSTRACT
The effect of hydropriming and halopriming with 0.5%, 1.0% and 1.5% concentrations of KCl, KH_2PO_4, $Mg(NO_3)_2$ and $MgSO_4$ salts on safe limit, germination and early seedling growth of six genotypes of wheat namely HI-1612, PBW–752, K–1317, WR–544, DBW–187 and HD–2967 collected from BAU, Ranchi was studied to know the comparative effect of priming on different varieties of wheat. The safe limit of seeds of different varieties of wheat showed a fluctuating trend in different salts at different concentrations which varied from a minimum of 5 h to a maximum of 8 h. The Priming effect appeared different with different genotypes. Halopriming with 0.5% concentration of both KH_2PO_4 and $Mg(NO_3)_2$ caused quickest germination in HI-1612. The radicle growth was most favoured by halopriming in HI-1612 variety at 1.0% KH_2PO_4 while 1.5% KCl favoured the plumule growth most in WR- 544. In general, hydro and halopriming were found favouring radicle and plumule growth in almost all the varieties. $Mg(NO_3)_2$ at 1.5% concentration appeared harmful for seed germination except in WR-544. The fresh weight of seedlings were found favoured by hydro and halopriming in PBW-752, K-1317 and HD-2967 wheat varieties.
Key words : Hydropriming, Halopriming, Wheat, Safe Limit, Early Seedling Growth.

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INTRODUCTION

Wheat is grown as a rabi crop and sown during winter in the month of November-December. It is an impotant cereal crop throughout Asian and African regions as well as several other country of the world. The wheat production in Jharkhand is much below the level of consumption on account of several constraints such as – undulating and slopy land with hard rock areas, water scarcity, acidic soils in the tanr areas, low soil fertility, low agricultural input due to poverty of farmers. Hence, low cost priming techniques might improve the growth and production of this crop

Seed priming techniques which can improve seedling vigor and establishment and consequently crop performance in the field [10]. During priming, seeds/grains are partially hydrated so that pre-germinations metabolic activities proceed, while radicle protrusion is prevented (Safe limit), and then dried back to the original moisture level. Several priming techniques are used for improving germinability seedling emergence and establishment and pest tolerance, better growth and yield. Hydropriming is pre-sowing soaking of seeds in water while in halopriming, various salt solutions are used for soaking the seeds for better germination, seedling growth, establishment and yield [8]. Improved results have been obtained in several crops as a result of priming such as maize, wheat, rice, canola [4]. The improvement in germination, seedling growth and establishment, crop performance and yield have been due to priming is attributed to various reasons such as – initiation of germination related processes, early DNA replication, increase RNA and protein synthesis, repair of deteriorated seed parts, enhanced embryo growth due to reduced leakage of metabolites, increase in various free radical scavenging enzymes such as – superoxide dismutase, catalase and peroxidase. Germination and seedling growth and establishment are essential factors for growth and yield of any plant species. Halopriming also called as osmopriming has been used by several workers [6,11,12]. to improve seed vigor in different plant species. A knowledge of safe limit is important to save the seeds from wastage during any such experiments involving priming technique. Faster germination and seedling emergence of primed seeds have been observed by several workers like [14 ,1 ,5] has observed that optimal priming treatment differ between species, cultivars and seed lots. This is most important limitation in finding out most suitable priming factor.

MATERIAL AND METHODS

The seeds/grains of six varieties/genotypes of wheat were procured from Birsa Agriculture University (BAU), Ranchi. Distilled water was used for soaking the wheat seeds for hydropriming whereas 0.5%, 1.0% and 1.5% solutions of KCl, KH_2PO_4, $Mg(NO_3)_2$ and $MgSO_4$ were prepared using distilled water for soaking the seeds for halopriming. Safe limit was found by soaking the seeds in distilled water and salt solution upto a period just before the protusion of radicle and priming was done after drying the soaked seeds to the original moisture level, such wheat seeds were called Hydropriming and Halopriming. Healthy primed seeds of wheat varieties were surface sterilized with 0.1% $HgCl_2$ for 2 minutes and thoroughly washed with distilled water. Distilled water was used as soaking medium for all germination experiments with hydroprimed and haloprimed seeds. Petridishes of 9 cm diameter containing filter paper (Whatman No. 41) kept over cotton pad were used for the germination experiments. Four replicates with 25 seeds each were maintained in the petridishes for each treatment and incubated at 30 ± 2^0C in Monochamber Seed Germinator. Seeds with visible emergence of radicle were taken as germinated and were scored first at every 30 minutes and later at every 24 h till 5 days. The length of radicle, plumule and fresh weight of seedling were taken at 96 h. The mean germination percentage was calculated on the basis of total number of germinated seeds.

RESULTS AND DISCUSSION

The result of safe limit of the six varieties of wheat under hydropriming and halopriming solutions has been recorded in Table-1. A fluctuating trend was observed as regards safe limit of the seeds primed under distilled water and different concentration of salts which showed a time span from 5 h to 8 h. A maximum safe limit of 8 h was shown by PBW-752 variety in 0.5% $Mg(NO_3)_2$ as well as 1.5% KCl solutions. The difference of duration of safe limit may be because of the slight difference in the metabolites of the varieties as also opined by[5]. that optimal priming techniques and treatment differs between species, cultivars and seed lots. The initial time lag recorded (Table-2) shows that in HI-1612, the time to start emergence of radicle has got reduced in 0.5%. KH_2PO_4 and $Mg(NO_3)_2$ concentration of salts to 5.45 h as compared to control and hydroprimed seeds with 6.0 h time. The result is in time with the finding of [16]. however, in other treatments, the time of emergence of radicle (initial time lag) was recorded to vary from 6.15 h to 7.0 h which is not in time with this finding. In PBW-752 ,the minimum and maximum duration taken to emergence of radicle was recorded to be 7.30 h to 8.30 h which was either similar to control and hydropriming (7.30 h) or more. In K-1317, initial time lag was found to the minimum of 6.30 h at 0.5%. $Mg(NO_3)_2$ as compared to control and any other treatments. In WR-544 variety a reduction in time of emergence of radicle (5.30 h) was recorded in 1.0% KH_2PO_4 as compared to control. This value in DBW-187 was found to 6.0 h at 0.5% KCl, KH_2PO_4 and $MgSO_4$. Quickest initiation of germination took 5.30 h was recorded in HD-2967 at 1.5% KH_2PO_4. Hydropriming did not appear to have any positive impact however, not all but halopriming with different salts at some particular concentrations caused quicker germination as compared to control (unprimed). The reduction in the timing of initiation of germination by halopriming is in line with the finding [15].

The variation in the results among genotypes may be attributed to genetic potential of the genotypes. Priming at a particular concentration suited most and favours and stimulates to produce enzymes like amylase and lipase which activate storage materials in seeds. Rehydration initiates early emergence of radicle due to the fact that all pregerminative processes for germination had already occurred in the seed [7] .has also observed reduction in initial time lag in rice using commercial fertilizer as priming agent.

Minimum time in initiation of germination (5.30 h) was taken in WR-544 and HD-2967 at 1.0% and 1.5% concentrations of KH_2PO_4 salts respectively followed by HI- 1612 (5.45 h) at 0.5% conc. of KH_2PO_4 and $Mg(NO_3)_2$, DBW-187 (6.0 h) at 0.5% conc. of KCl, KH_2PO_4 and $MgSO_4$, K-1317 (6.30 h) at 0.5% $Mg(NO_3)_2$ and in PBW-752 (7.0 h) at 0.5% $MgSO_4$. The priming effect appeared different with different wheat varieties which is in line with the findings [11]. Almost no significant beneficial effect was detected between control and hydropriming as regards initial time lag. The delay in initiation of germination at most of the salt concentration may be due to the phytotoxic effects in the process of germination which is in line with the findings[9].

The length of radicle recorded in Table-3 showed that in general, hydropriming and halopriming with KCl, KH_2PO_4, $Mg(NO_3)_2$, and $MgSO_4$ salts at 0.5%, 1.0% and 1.5% concentrations favoured increase in radicle length except in few cases. In HI-1612 maximum radicle growth of 9.96 cm was recorded in 1.0% KH_2PO_4 whereas in PBW-752 it was 9.0 cm in 1.0% $MgSO_4$, in K-1317 (8.96 cm) in 1.0% $MgSO_4$, in WR-544 (9.70 cm) in 1.5% KH_2PO_4 and in DBW-187 (9.56 cm) in 1.0% $MgSO_4$ as compared to control. The growth of radicle length was favoured most (9.16 cm) due to hydropriming in HD-2967. Beneficial effect of hydropriming and halopriming was observed in almost all the varieties of wheat. Similar results were recorded [17]. in wheat. However, [3] did not find any significant increase in radicle length due to priming in watermelon. The beneficial priming effect was due to early DNA replication, increased RNA and protein synthesis, faster embryo growth and repair of deteriorated seed parts. The growth of plumule length (Table-3) also followed the same trend of radicle length. The growth and length of plumule was also promoted by hydropriming and halopriming salt solutions as compared to control. The maximum value of plumule length (10.23 cm) was achieved in WR-544 at 1.5% KCl solution followed by HI-1612 (9.30 cm), HD-2967 (9.06 cm), DBW-187 (9.03 cm), PBW-752 (8.83 cm) and K-1317 (8.40 cm). The result is in line with the finding of [16,17] . but not in agreement with the findings of [3,2]. who did not find any significant beneficial impact of priming.

The result of percentage germination recorded in Table-4 indicated that the germinination percentage was adversely affected only at some concentration of salts and in hydrogriming otherwise 100% germination level was generally achieved in all varieties. $Mg(NO_3)_2$ at 1.5% conc. appeared harmful except in WR- 544 which appeared superior to all. The fresh weight of seedling measured after 96 h has been recorded in Table-4 showed that hydropriming and halopriming with the salts at different concentrations have caused an increase as compared to control in all the varieties of wheat under reference. Maximum seedling fresh weight in HI- 1612 was recorded (210.0 mg) in hydroprimed seed whereas in PBW-752 it was (210.66 mg) in 1.5% $Mg(NO_3)_2$, in K-1317 (204.0 mg) in 1.5% KH_2PO_4 in WR-544 (202.0 mg) in 1.0% KCl, in DBW- 187 (214.66 mg) in 0.5% KCl and HD- 2967 (210.66) in 0.5% $MgSO_4$. The increase in the value of seedling fresh weight recorded after 96 h was found to be maximum in DBW- 187 (214.66 mg) in 0.5% KCl. These results are in line with the finding) [3,16,12,11].

It can be concluded that hydropriming and halopriming have beneficial impact on all the wheat varieties under reference as regards radicle growth, plumule growth and fresh weight of seedlings. The difference in response among the varieties was because of the differences in their genotypes. No beneficial impact of hydropriming and halopriming was observed as regards time of germination.

Table 1 - Effect of hydro and halopriming with K (KCl& KH_2PO_4) and Mg ($Mg(NO_3)_2$ &$MgSO_4$) salts with 0.5%, 1.0% and 1.5% concentrations on the safe limit of six genotypes (varieties) of Wheat (*T. aestivum* L.) var. HI-1612, PBW-752, K-1317, WR- 544, DBW- 187 and HD- 2967.

Parameters		**Safe Limit (hr)**					
Variety		HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967
Control (unprimed)		5.30	7.00	7.00	5.30	6.30	7.00
Hydroprimed (dist. water)		5.00	7.30	6.30	6.00	6.00	7.00
Haloprimed **Salt Conc.**							
0.5% Conc.							
KCI	-	5.45	7.00	7.00	6.00	5.30	6.00
KH_2PO_4	-	5.00	6.00	6.00	5.15	5.30	5.30
$Mg(NO_3)_2$	-	5.30	8.00	6.00	6.00	6.30	6.00
MgSO4	-	5.30	6.30	6.00	5.30	5.30	6.00
1.0% Conc.							
KCI	-	5.45	7.30	7.00	5.30	6.00	6.30
KH_2PO_4	-	6.30	7.30	7.30	5.00	6.45	7.30
$Mg(NO_3)_2$	-	6.15	7.30	7.30	6.00	7.00	6.15
MgSO4	-	6.00	7.00	7.30	6.00	6.00	6.30

1.50% Conc.

KCI	-	6.30	8.00	7.45	5.30	7.00	7.30
KH_2PO_4	-	6.00	7.00	7.00	5.30	7.00	5.00
$Mg(NO_3)_2$	-	6.15	7.30	7.30	6.00	6.30	6.45
$MgSO^4$	-	6.00	7.00	6.30	5.20	7.00	5.20

Table 2 - Effect of hydro and halopriming with K (KCl& KH_2PO_4) and Mg ($Mg(NO_3)_2$ & $MgSO_4$) salts with 0.5% , 1.0% and 1.5% concentrations on germination and early seedling growth (germination time/initial time lag) of six genotypes (varieties) of wheat (*T. aestivum* L.) var. HI-1612, PBW- 752, K- 1317, WR- 544, DBW- 187 and HD- 2967.

Parameters	**Initial Time Lag/Germination Time (hr)**					
Variety	HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967
Control (unprimed)	6.00	7.30	7.30	6.00	7.30	7.30
Hydroprimed (dist. water)	6.00	7.30	6.45	6.30	7.30	7.30
Haloprimed **SaltConc.** **0.5% Conc.**						
KCI -	6.15	8.00	7.30	6.30	6.00	6.30
KH_2PO_4 -	5.45	8.00	8.00	6.15	6.00	6.00
$Mg(NO_3)_2$ -	5.45	8.30	6.30	6.00	7.00	6.15
$MgSO^4$ -	6.00	7.00	6.45	6.00	6.00	6.30
1.0% Conc.						
KCI -	6.30	8.00	7.30	6.00	6.30	7.00
KH_2PO_4 -	7.00	8.00	8.00	5.30	7.00	8.00
$Mg(NO_3)_2$ -	6.45	8.30	8.15	6.30	7.30	6.45
$MgSO^4$ -	6.30	7.30	8.00	6.30	6.30	7.00
1.50% Conc.						
KCI -	7.00	8.30	8.15	6.00	7.30	8.00
KH_2PO_4 -	6.30	7.30	7.30	6.00	7.30	5.30
$Mg(NO_3)_2$ -	6.45	8.00	8.00	6.30	7.00	7.15
$MgSO^4$ -	6.30	7.30	7.00	6.00	7.30	6.00

Table 3 - Effect of hydro and halopriming with K (KCl& KH2 PO4) and Mg (Mg(NO3)2 &MgSO4) salts with 0.5% , 1.0% and 1.5% concentrations on germination and early seedling growth (length of radicle &plumule after 96 hr) of six genotypes (varieties) of Wheat (T. aestivum L.) var. HI-1612, PBW- 752, K-1317, WR- 544, DBW- 187 and HD- 2967.

Parameters	**Length of Radicle (cm)**						**Length of Plumule (cm)**					
Variety	HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967	HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967
Control (unprimed)	9.00	8.00	7.60	8.40	7.70	6.00	7.40	6.80	6.00	8.20	8.10	7.00
Hydroprimed (dist. water)	8.66	7.30	8.43	9.43	8.16	9.16	9.06	8.30	7.90	8.23	8.70	7.10
Haloprimed **Salt Conc.** **0.5% Conc.**												
KCI	9.56	8.36	8.56	8.90	8.83	8.10	8.96	8.56	8.23	9.13	8.80	8.20
KH_2PO_4	8.76	8.10	8.36	8.56	8.60	8.36	9.30	8.33	7.33	9.50	8.46	8.33
$Mg(NO_3)_2$	7.70	6.83	7.70	8.60	8.06	6.60	8.60	7.70	7.33	8.80	8.16	7.46
$MgSO^4$	8.43	8.00	8.46	8.50	8.33	8.56	8.76	8.83	7.73	8.70	8.83	8.10
1.0% Conc.												
KCI	9.16	6.70	7.60	8.16	8.73	7.50	9.20	7.60	7.20	9.43	8.93	7.50
KH_2PO_4	9.96	8.46	8.03	9.13	8.26	8.26	8.83	7.96	7.66	9.60	9.06	9.06
$Mg(NO_3)_2$	7.96	8.10	7.86	7.96	8.40	7.40	8.40	8.03	7.20	9.03	8.50	7.96
$MgSO^4$	9.86	9.00	8.96	9.00	9.56	9.00	8.13	7.20	7.73	8.50	8.46	8.10
1.50% Conc.												
KCI	9.23	8.23	7.70	8.96	9.13	8.10	8.63	7.56	6.46	10.23	8.60	8.33
KH_2PO_4	8.90	8.13	7.83	9.70	8.60	8.33	9.10	8.46	8.40	9.43	9.03	9.00
$Mg(NO_3)_2$	9.46	8.26	7.23	8.16	8.13	8.50	9.20	8.23	7.16	9.16	8.80	7.70
$MgSO^4$	9.40	8.90	8.66	8.50	8.56	7.70	8.20	7.36	8.16	9.23	8.26	7.56

Table 4 - Effect of hydro and halopriming with K (KCl& KH_2PO_4) and Mg ($Mg(NO_3)_2$ &$MgSO_4$) salts with 0.5% , 1.0% and 1.5% concentrations on germination and early seedling growth (Percentage Germination & Fresh Weight of Seedling after 96 hr) of six genotypes (varieties) of Wheat (*T. aestivum* L.) var. HI-1612, PBW- 752, K- 1317, WR- 544, DBW- 187 and HD- 2967.

Parameters	**Percentage Germination (%)**						**Fresh Weight of Seedlingafter 96 h (mg)**					
Variety	HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967	HI-1612	PBW-752	K-1317	WR-544	DBW-187	HD-2967
Control (unprimed)	100	100	100	100	100	100	160.00	178.00	147.00	170.00	175.00	160.00
Hydroprimed (dist. water)	100	100	100	90	100	85	210.00	193.33	188.66	196.00	204.00	186.00
Haloprimed SaltConc. 0.5% Conc.												
KCI	100	100	100	95	100	90	191.33	203.33	201.33	189.33	214.66	188.66
KH_2PO_4	100	100	100	100	100	100	164.66	186.00	183.33	168.66	182.66	160.00
$Mg(NO_3)_2$	100	100	100	100	100	100	181.33	192.66	202.66	172.00	204.66	177.33
$MgSO^4$	100	100	100	100	100	100	162.00	208.00	196.66	157.00	199.33	210.66
1.0% Conc.												
KCI	100	100	100	100	100	100	178.66	177.33	194.00	202.00	206.00	170.66
KH_2PO_4	100	100	100	100	100	100	176.00	177.66	189.33	182.66	199.00	174.66
$Mg(NO_3)_2$	100	100	100	100	100	100	177.33	189.33	183.33	182.00	192.66	176.00
$MgSO^4$	100	100	100	100	100	100	186.00	195.33	194.00	180.66	175.33	167.33
1.50% Conc.												
KCI	100	100	100	100	100	100	163.33	178.66	174.66	166.00	201.33	179.33
KH_2PO_4	100	100	100	100	100	100	159.33	200.66	204.00	158.66	190.66	177.33
$Mg(NO_3)_2$	73	90	78	100	85	85	206.00	210.66	198.66	186.00	202.66	186.00
$MgSO^4$	100	100	100	100	100	100	183.33	193.33	196.66	184.00	204.66	183.33

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