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Effect of seed priming treatments on seed yield & yield attributes of Wheat (*Triticum aestivum* L.) seeds under well watered & rainfed conditions

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Abstract

The present study was conducted on wheat variety "K-9351 (Mandakini)" and was procured from Seed Processing Plant, C.S Azad University of Agriculture & Technology, Kanpur. The experiment was conducted in Rabi 2014-15 and 2015-16. The seeds were used for seed priming treatments, *i.e.*$T_{1=}$ Control (Unprimed), $T_{2=}$ Priming with tap water, $T_{3=}$ Priming with KNO_3 (2.5%), $T_{4=}$ Priming with GA_3 (50ppm), $T_{5=}$ Priming with $Cacl_2$ (1%), $T_{6=}$ Priming with NaCl (1%) & $T_{7=}$ Priming with KH_2 PO_4 (1%). Priming was done by soaking of required quantity of seeds of wheat variety Mandakini K-9351 in tap water and various chemicals' concentration for 12 hrs in ratio of 1:1 (Kg of seeds/volume of solution) by using wet gunny bags. Then the treated or primed seeds were dried in shade to maintain the seed moisture content approximately 12 or 13%. Seed dressing was done on primed and untreated (control) by Thiram (2.5%). Seeds priming were KNO_3 @ 2.5% on wheat variety Mandakini (K-9351) significantly improved the seed yield & yield parameters with percent increase of 27.02 & 20.36 in final plant stand in $1m^2$ area, 36.48 & 15.93 in harvest index (%) , 33.05 & 37.19 in number of effective tillers/plant, 31.07 & 41.89 in number of seeds/spike, 10.63 in Spike length (Well watered condition), 25.17 & 20.61 in Seed yield/plot (kg) & 25.19 & 20.38 in Seed yield (q/ha), over unprimed or control whereas percent decrease in days to 75% crop stand & days to 75% flowering was observed in GA_3 (50 ppm) as (31.61 & 3.84) & (23.52 & 3.04) respectively under irrigated and rain fed conditions, respectively.

Keywords: Wheat, Seed Priming, Yield characters.

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal in many developed and developing countries of the world. It is grown all over India from the sea level up to an elevation of 3500 m in the Himalaya. In Uttar Pradesh, productivity of wheat is low, which needs improvement, the main causes of low productivity of wheat in U.P. is its delayed sowing in sizeable area after harvesting the toria, early potato, late paddy, sugarcane, ratoon and early pigeon pea etc. Stand establishment is of primary importance for optimizing field production of any crop plant. At suboptimal conditions of environment conditions, poor seed germination and subsequently poor field establishment is a common phenomenon. It has been reported that one of the major obstacles to high yield and production of crop plants is the lack of synchronized crop establishment due to poor weather and soil conditions (Mwale *et al*., 2003). On the other hand seeds are occasionally sown in seedbeds having unfavorable moisture because of the lack of rainfall at sowing time which results in poor and unsynchronized seedling emergence (Angadi and Entz, 2002). Seed germination is negatively affected by drought (Damirkaya *et al*., 2006) [8]. It has been declared that priming had resulted in more germination speed especially in drought stress and low temperatures in sorghum, sunflower and melon (Sivritepe *et al*., 2003) [26]. Priming allows some of the metabolic processes necessary for germination to occur without germination take place. In priming, seeds are soaked in different solutions with high osmotic potential. This prevents the seeds from absorbing enough water for radicle protrusion, thus suspending the seeds in the lag phase (Taylor *et al*., 1998) [27]. Seed priming has been commonly used to reduce the time between seed sowing and seedling emergence and to synchronize emergence (Parera and Cantliffe, 1994) [25]. Various seed priming techniques have been developed which include hydro-priming, halo-priming, osmo-priming and hormonal priming. Ashraf *et al*., (2001) found that GA_3 treatment enhanced the vegetative growth of two wheat cultivars. It enhanced the deposition of Na+ and Cl- in both root and shoots of wheat plant. It also caused a significant increase in photosynthetic at the vegetative stage of the crops. Improving in priming is affected by many factors such as plant species, priming media, its concentration, priming duration, temperature and storage conditions etc. With the proper treatment of seeds they are able to germinate and emerge better as the inorganic salts improve germination and growth parameters of the treated seed; KCl increases the protein and starch content in grains and KNO_3 increases yield, fruit size and improves quality in field and vegetables crops. The present investigation is therefore, planned to assess the effect of seed priming treatments on seed yield & its attributing characters and to identify the suitable seed priming treatment for getting higher seed yield under irrigated and rainfed conditions.

Materials & Methods

The experiment was conducted on wheat variety "K-9351 (Mandakini)". The good quality seeds of wheat variety were procured from Seed Processing Plant C.S Azad University of Agriculture & Technology, Kanpur. The experiment was conducted in Rabi 2014-15 and 2015-16. Following chemicals and their concentration were used for pre-sowing seed treatments.$T_{1=}$ Control (Unprimed), $T_{2=}$ Priming with tap water, $T_{3=}$ Priming with KNO_3 (2.5%), $T_{4=}$ Priming with GA_3 (50ppm), $T_{5=}$ Priming with $Cacl_2$ (1%), $T_{6=}$ Priming with NaCl(1%) & $T_{7=}$ Priming with $KH_2\,PO_4$ (1%). Seed treatment or priming was done by soaking of required quantity of seeds of wheat variety Mandakini K-9351 in tap water and various chemicals' concentration for 12 hrs in ratio of 1:1 (Kg of seeds/volume of solution) by using wet gunny bags. Then the treated or primed seeds were dried in shade to maintain the seed moisture content approximately 12 or 13%. Seed dressing was done on primed and untreated (control) by Thiram (2.5%). Primed seeds along with control (untreated) were sown in two separate experiments for irrigated and rainfed conditions and crop was raised with application of 5 irrigations and no irrigations, respectively, in 4 replications by using RBD design for both at New Dairy Farm, Kalyanpur, Kanpur, respectively. The crop was raised by using all required agronomical practices. Mature crop was harvested in the last week of April 2015 & 2016. The following field observations were recorded. Days to 75% crop stand, Days to 75% flowering (anthesis), Days to harvest maturity, Final plant stand in $1m^2$ area, Biomass/plot (kg), Harvest Index (%), Number of effective tillers/plant, Number of seeds/spike, Spike length, Seed yield/plot (kg) & Seed yield (q/ha).

Statistical Analysis of Data

The analysis of data was done following the Randomized Complete Block Design for each character. ANOVA helps in partitioning the total variance into three components viz., replication, treatment and error. The steps employed are given below. The various statistical techniques were used for calculation of the data as suggested by Panse and Sukhatme (1967). The analysis of variance was worked out to test the differences among genotypes by F-test.

Skeleton for Analysis of Variance

Source of Variation	d f	S.S	M.S.S	F-value cal
Due to replications	(r-1)	RSS	RSS/(r-1)= MSS(r)	MSS(r)/EMS
Due to treatment	(t-1)	TrSS	TrSS/(t-1) = MSS(t)	MSS(t)/EMS
Due to error	(r-1) x (t-1)	ESS	ESS/(r-1) (t-1) = EMS	
Total	(rt-1)	TSS		

Where,
r = Number of replication
t = Number of treatments
SSR = Sum of squares due to replication
TrSS = Sum of squares due to treatment
SSE = Sum of squares due to error
TSS = Total sum of squares
MSS (r) = Mean sum of squares due to replication
MSS (t) = Mean sum of squares due to treatment
EMS = Error mean sum of squares

Standard error of mean

Standard error of mean was calculated by the following formula:

$$SEM = \frac{\sqrt{2EMS}}{r}$$

Critical difference (C.D.)

Critical difference was calculated by the following formula:

$$CD = \frac{\sqrt{2EMS}}{r} \text{ x t value}$$

Where,
EMS = Error mean sum of squares.
R = Number of replications.
t value = table value at error degree of freedom at 5% level of significance.

Significant 'F' value indicates that there is a significant difference among the treatment. But to compare any two particular treatments, it is tested against C.D. value.

Test of significance

If the variance ratio (or) f- calculated value {MSt per MSv} or treatment was greater than the f-table value at 5% and 1% level of significance, the variance between treatments was considered to be significant. If the f- calculated value is more than the f- tabulated value, the difference between treatments were considered to be non- significant.

Mean performance

Mean = mean value of each character was worked out by dividing the total by the corresponding number of observations.

$$\text{Mean } (\bar{x}) = \frac{\sum x}{N}$$

Where,
$\sum x$ = sum of all the observations for each character in each replication
N = corresponding number of observations

Results and Discussion

The result recorded for both years were pooled during the experimental findings have been discussed and mentioned in this chapter in terms of causes and their effects relationship. The beneficial effects of seed priming have been demonstrated for many field crops such as wheat, sweet corn, mung bean, barley, lentil, cucumber etc. (Sadeghian and Yavari, 2004). Rehman *et al.*, (2011) reported that seed priming is a cost effective technology that can enhance early crop growth leading to earlier and more uniform stand with yield associated benefits in many field crops including oilseeds.

Seed priming has been found a double beneficial technology to enhance rapid and uniform emergence and to achieve high vigour as well as better yield in field crops. Many studies have been carried out on the effect of seed priming on germination and growth rate of crop. Seeds spend a great deal of time just absorbing water from the soil. If this time is minimized, seed germination and seedling emergence can be significantly speeded up. The easiest way to do this is to soak the seeds in water before sowing (Harris, 1999) [15], a phenomenon called hydro- priming. In recent years, seed osmopriming has been tested in over 1000 trials in India, Pakistan, Nepal, Bangladesh and Zimbabwe on a range of crops including maize (*Zea mays*), sorghum (*Sorghum bicolor*), rice (*Oryza sativa*), wheat (*Triticum spp.*) and Chickpea (*Cicer arietinum*) (Harris *et al*. 2001) [16]. Seed priming is a controlled hydration process followed by re-drying that allows seeds to imbibe water and begin internal biological processes necessary for germination, but which does not allow the seed to actually germinate. A robust seedling establishment enhances competitiveness against weeds, improves tolerance to environmental stresses and maximizes biological and grain yields (Hosseein *et al.* 2011) [17]. Potassium hydro phosphates (KH_2PO_4), have been introduced as the osmoticum which have shown good potential to enhance germination, emergence, growth, and grain yield of wheat (Misra and Dwibedi, 1980) [21]. Several research worker primed the seeds by gibberellic acid (GA_3) which is the most important growth regulator used for seed germination, mobilization of food in seed storage cell, cell elongation, permeability of cell membrane, apical bud dormancy, flowering and fruiting growth. Besides these GA_3 induce synthesis of hydrolytic enzyme, primed corn and wheat seed respectively by Barsa *et al.* (1989) [5] and Ajirloo *et al.* (2013) [2] Potassium nitrate (KNO_3) is the most common known chemical for promoting seed germination. It may interact with temperature and influencing the seed physiology finally, germination and vigour are improved.

Poor crop establishment is a major problem in wheat production due to low soil moisture under rain fed condition (Murungu 2011) [24] and due to this seed emergence and germination are negatively affected in beds (Bougne *et al.* 2000, Sivritepe *et al.* 2003, Damirkaya *et al.* 2006) [7, 26, 8]. Primings may help seed production under rain fed condition by ensuring fast; improve germination vigourously (Harris *et al.* 2001) [16].

Table 1: Mean table for the effect of seed priming on seed yield & yield parameters under Irrigated Condition

Treatments	Days to 75% Crop Stand	Days to 75% flowering	Days to Harvest Maturity	Final Plant Stand in1m^2 area	Biomass/plot (kg)	Harvest Index %	Number of effective tillers/plant	No. of. Seeds/Spike	Spike Length (cm)	Seed yield/ plot(kg)	Seed yield (q/ha)
(T_0) Control	9.87	94.12	142.50	33.75	7.96	35.36	13.25	40.55	8.84	2.90	29.05
(T_1) Tap water	8.00	92.62	138.40	38.50	8.48	41.63	14.88	43.90	9.37	3.52	35.22
(T_2) KNO_3 (2.5%)	7.50	91.12	134.90	42.87	7.73	48.26	17.63	53.15	9.78	3.63	36.37
(T_3) GA_3 (50 ppm)	6.75	90.50	139.62	36.50	7.84	40.27	14.62	43.40	9.18	3.35	33.53
(T_4) C_aCl_2 (1%)	8.25	93.25	140.50	36.12	7.74	41.18	14.00	42.73	9.10	3.26	32.66
(T_5) Na Cl (1%)	8.25	93.50	142.25	35.25	8.28	34.44	13.75	41.75	9.02	3.17	31.78
(T_6) KH_2PO_4 (1%)	7.75	92.00	136.90	40.37	7.75	47.15	16.00	47.78	9.49	3.58	35.88
S.E.D	0.43	0.61	1.04	1.39	0.47	3.35	0.36	2.70	0.26	0.16	1.69
C.D.	1.08	1.51	2.59	3.43	NS	8.29	0.91	6.68	0.66	0.41	4.18

Table 2: Mean table for the effect of seed priming on quality parameters under Rainfed Condition

Treatments	Days to 75% Crop Stand	Days to 75% flowering	Days to Harvest Maturity	Final Plant Stand in1m^2 area	Biomass/plot (kg)	Harvest Index %	Number of effective tillers/plant	No. of. Seeds/Spike	Spike Length (cm)	Seed yield/ plot(kg)	Seed yield (q/ha)
(T_0) Control	8.50	90.12	136.75	32.50	6.79	33.32	11.75	34.90	8.60	2.28	22.86
(T_1) Tap water	7.25	89.00	132.10	37.62	6.88	37.59	13.12	42.26	9.20	2.62	26.22
(T_2) KNO_3 (2.5%)	6.75	87.88	128.90	39.12	6.96	38.63	16.12	49.52	9.47	2.75	27.52
(T_3) GA_3 (50 ppm)	6.50	87.38	133.75	35.50	6.91	36.52	12.62	41.07	9.10	2.55	25.57
(T_4) C_aCl_2 (1%)	7.25	89.37	134.75	34.37	6.94	35.39	12.25	39.43	8.83	2.48	24.86
(T_5) NaCl (1%)	7.25	89.62	135.87	33.75	6.96	34.06	12.12	36.05	8.69	2.37	23.75
(T_6) KH_2PO_4 (1%)	7.00	88.63	130.80	38.62	6.82	38.17	14.37	46.08*	9.36	2.64	26.42
S.E.D	0.46	0.54	1.24	1.08	0.14	1.32	0.70	2.30	0.31	0.10	1.02
C.D.	1.14	1.33	3.07	2.68	NS	3.27	1.74	5.69	NS	0.25	2.52

Effect of seed priming treatments on seed yield parameters & seed yield.

Under irrigated condition –

Significant effect of various pre-sowing seed priming treatments (control), (tap water), (KNO_3 @ 2.5%), (GA_3 @ 50ppm), ($CaCl_2$ @ 1%), (NaCl @ 1%) and (KH_2PO_4 @ 1%) were found on seed quality in terms of Days to 75% crop stand, Days to 75% flowering (anthesis), Days to harvest maturity, Final plant stand in $1m^2$ area, Biomass/plot (kg), Harvest Index (%), Number of effective tillers/plant, Number of seeds/spike, Spike length, Seed yield/plot (kg) & Seed yield (q/ha) under irrigated condition (Table 2). Similar findings are given by Harris *et al.* (2001) [16], Giri *et al.* (2003) [13], Farooq *et al.* (2006) [10], Tian *et al.* (2014) [28] and Toklu *et al*. (2015) [29].

Seed priming treatment of KNO_3 gave significantly highest percent improvement over control for Days to harvest maturity, Final plant stand in $1m^2$ area, Harvest Index (%), Number of effective tillers/plant, Number of seeds/spike, Spike length (cm), Seed yield/plot (kg) & Seed yield (q/ha) and showed 5.33 (% decrease), 27.02, 36.48, 33.05, 31.07, 10.63, 25.17 & 25.19 %, improvement with values of 132.90 days, 42.97 plants, 48.26 %, 17.63 effective tillers, 53.15 seeds, 9.78cm, 3.63kg, and 36.37 q/ha respectively. These findings were strongly supported by Misra and Dwibedi, (1980) [21], Basra *et al.* (1989) [5], Assefa *et al*., (2010), Yari *et al*., (2010), Ghobadi *et al.* (2012) [12], Ajirloo *et al*. (2013) [2], Hamidi *et al*. (2013) [14] & Tiwari T.N. *et al*.(2016).

Next seed priming treatment was KH_2PO_4, which showed significantly similar performance & at par to KNO_3 for improving the Final plant stand in $1m^2$ area, Harvest Index (%), Number of seeds/spike, Spike length (cm), Seed yield/plot (kg) & Seed yield (q/ha) and showed 3.92 (% decrease), 19.61, 33.34, 17.82, 7.35, 23.44 & 23.51 % improvement with values of 136.90 days, 40.37 plants, 47.15 %, 47.78 seeds, 9.49cm, 3.58kg, and 35.88q/ha respectively over unprimed seeds. Seed priming with tap water also showed significant improvement over unprimed seeds and ranked 3rd for Harvest Index (%), Spike length (cm), Seed yield/plot (kg) & Seed yield (q/ha) whereas percent increase over control were 17.73, 5.99, 21.37, and 21.23 but was at par with KNO_3 & KH_2PO_4. These findings were strongly supported by Moradi Dezfuli *et al.* (2008) [22] in maize and Farooq *et al.* (2008) [11], Arief *et al.* (2011) [4], Lemrasky *et al.* (2012) [18], Hamidi *et al.* (2013) [14], Ali *et al.* (2013) [3], Toklu *et al.* (2015) [29] in wheat.

Significantly similar performance was exhibited by tap water for Days to 75% crop stand, days to 75% flowering (anthesis), Days to harvest maturity, Final plant stand in $1m^2$ area, Number of effective tillers/plant & Number of seeds/spike with values 8.00 days, 92.62 days, 138.40 days, 38.50 plants, 14.88 tillers & 43.90 seeds respectively followed by NaCl, $CaCl_2$ & GA_3 that scored nearly similar values and were at par to control that exhibited 9.87 days, 94.12 days, 142.50 days, 33.75 plants, 13.25 tillers & 40.55 seeds. With respect to biomass/plot (kg) the result was non-significant and Tap water ranked 1st by exhibiting 8.48 kg, followed by other treatments. It was very much clear for the findings of experiment that untreated or unprimed (control) seeds exhibited significantly inferior performance than KNO_3 and KH_2PO_4. These results are in accordance with the finding of Basra *et al.* (2005) [5], Bassi (2005), Moradi Dezfuli *et al*., (2008) [22], Khan *et al*., (2009), Arief *et al* (2011) [4], Ghobadi *et al.* (2012) [12], Ghassemi-Golezani *et al*. (2013), Hamidi *et al*. (2013) [14], Tian *et al*. (2014) [28]. It was very much clear from the findings of experiment that untreated or unprimed (control) seeds exhibited significantly inferior performance regarding Days to 75% crop stand, Days to 75% flowering (anthesis), Days to harvest maturity, Final plant stand in $1m^2$ area, Biomass/plot (kg), Harvest Index (%), Number of effective tillers/plant, Number of seeds/spike, Spike length, Seed yield/plot (kg) & Seed yield (q/ha). Priming treatments KNO_3 and KH_2PO_4 showed best performance among all the treatments and were at par with each other

Under rain fed condition

Seed priming treatments of various chemicals viz. control, tap water, KNO_3 (2.5%), GA_3(50ppm),$CaCl_2$ (1%), NaCl (1%) and KH_2PO_4 (1%) showed significant influence on all the seed yield parameters and seed yield those were observed i.e. Days to 75% crop stand, Days to 75% flowering (anthesis), Days to harvest maturity, Final plant stand in $1m^2$ area, Biomass/plot (kg), Harvest Index (%), Number of effective tillers/plant, Number of seeds/spike, Spike length, Seed yield/plot (kg) & Seed yield (q/ha). Poor crop establishment is a major problem in wheat production under rain fed condition Murungu (2011) [24]. Various scientists reported that priming treatments significantly increased the strength of the seeds to face the moisture or stress condition of the field under drought or low rain condition. (Demir and Van de Venter 1999, Bougne *et al.* 2000, Harries 2001, Sivritepe *et al.* 2003, Damirkaya *et al*.2006) [9, 7, 16, 26, 8].

Seed priming treatments of KNO_3 significantly improved the all seed yield parameters & seed yield with percent increase of 20.36 in final plant stand in $1m^2$ area, 15.93% in harvest index, 37.19 plants in number of effective tillers/plant, 41.89 in number of seeds/spike, 20.61 in seed yield/plot (kg) & 20.38 in seed yield (q/ha) while percent decrease of 5.74 in days to harvest maturity (table.3). This treatment showed the highest improvement in seed yield parameters due to its nutrition value. It is composed of 100% plant macronutrients. It comprises of potassium cation (K^+) and nitrate anion (NO_3^-), with N-P_2O_5-K_2O analysis of 13-0-46. (13% nitrogen are equivalent to 62% NO_3^- and 46% K_2O are equivalent to 38% K^+ summing upto 100% KNO_3)**.** Potassium nitrate is the only chemical that supplies both macronutrients, highest in the composition of any plant Haifa (2009). The nitrate (NO_3) could be absorbed, being used in the metabolism of the embryo, through the enzyme nitrate reductase (NR). Besides, the priming could also activate the response of the antioxidant system, making the primed seeds more prepared for possible stresses. These results are in accordance with Harris *et al*. (2001) [16], Basra *et al.* (2005) [5], Moradi Dezfuli *et al*., (2008) [22], Arief *et al* (2011) [4], Murungu (2011) [24], Ghobadi *et al.* (2012) [12], Ghodrat and Rousta, (2012), Ghassemi-Golezani *et al*. (2013), Ali *et al*. (2013) [3], Iqbal and Ashraf (2013) [23], Hussain *et al* (2013), Toklu *et al*. (2015) [29] & Tiwari T.N. *et al*.(2016).

Next to best KNO_3 was KH_2PO_4 priming treatment which exhibited statistically similar performance to KNO_3 for Final plant stand in $1m^2$ area, Harvest Index (%), Number of seeds/spike, Seed yield/plot (kg), Seed yield (q/ha) & Days to harvest maturity with percent increase of 18.83, 14.55, 32.03, 15.78, 15.44 and percent decrease of 4.35 over unprimed seeds. It may be due to supply of Phosphorus from KH_2PO_4 that increased the nutrient uptake by seedlings at the time of germination. It showed a relatively positive effect presumably because phosphorous reserves in the seed play very important role in the metabolism of germinating seed. Seed priming treatments of tap water stood at par to KNO_3 and KH_2PO_4 for

Final plant stand in $1m^2$ area, Harvest Index (%), Seed yield/plot (kg) & Seed yield (q/ha) with values of 37.62 plants, 37.59 (%), 2.62 kg/plot & 26.22 q/ha. These findings were strongly supported by (Morunugu, 2011, Ali *et al*, 2013) [24, 3], Misra and Dwibedi, (1980) [21], Basra *et al*. (1989) [5], Assefa *et al*., (2010), Yari *et al*., (2010), Ghobadi *et al.* (2012) [12], Ajirloo *et al*. (2013) [2], Hamidi *et al*. (2013) [14] & Tiwari T.N. *et al*.(2016) but stood significantly inferior to $KNO_3$and KH_2PO_4. Treatments GA_3 significantly affected the days to 75% crop stand & 75% flowering (anthesis) with percent decrease of 23.52 & 3.04 respectively. The effect of the priming treatments were non-significant for biomass/plot (kg) & spike length (cm). Numerically KNO_3 & NaCl ranked 1st by exhibiting 6.96 kg each for biomass/plot (kg), followed by $CaCl_2$, GA_3 & Tap water. With respect to spike length numerically again KNO_3 ranked 1st in improving the length of spike, followed by KH_2PO_4, Tap water, GA_3, $CaCl_2$ & NaCl. These values were at par with Control.

Conclusion

It was concluded that seed priming treatments of KNO_3 @ 2.5% on wheat variety Mandakini (K-9351) significantly improved the seed quality with percent increase of 27.02 & 20.36 in final plant stand in $1m^2$ area, 36.48 & 15.93 in harvest index (%) , 33.05 & 37.19 in number of effective tillers/plant, 31.07 & 41.89 in number of seeds/spike, 10.63 in Spike length (Irrigated condition), 25.17 & 20.61 in Seed yield/plot (kg) & 25.19 & 20.38 in Seed yield (q/ha), Percent decrease in days to 75% crop stand & days to 75% flowering was observed in GA_3 (50 ppm) as (31.61 & 3.84) & (23.52 & 3.04) respectively. Next treatment was KH_2PO_4 @ 1% followed by tap water for both conditions but among all the treatments, KNO_3 was found to be the best which was at par with KH_2PO_4 for both the conditions.

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