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Inducement of Seed Priming with Potassium Nitrate on quality Performance of Chickpea (*Cicer arietinum* L.)

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ABSTRACT: Seed priming is a pre-sowing treatment which results in a physiological condition that allows seed to germinate more efficient. During subsequent germination, primed seeds exhibit a faster and more synchronized germination and young seedlings are often more vigorous against abiotic stresses than seedlings obtained from unprimed seeds. Priming often involves soaking seed in predetermined amounts of water or limitation of the imbibition time. The imbibition rate may well be somehow controlled by specific salt agents like KNO_3. The laboratory experiment was carried out in seed testing laboratory, Department of Seed science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India. This study investigated the germination and seedling vigour of chickpea variety 'Anuradha' under different KNO_3 concentration and duration with the objective of enhancing the germination potential before sowing. In the present experiment therefore an attempt has been made to study the effects of seed priming with 50 ppm KNO_3 for 6 hrs, 50 ppm KNO_3 for 8 hours, 50 ppm KNO_3 for 10 hours; 100 ppm KNO_3 for 6 hrs, 100 ppm KNO_3 for 8 hrs, 100 ppm KNO_3 for 10 hours; 200 ppm KNO_3 for 6 hours, 200 ppm KNO_3 for 8 hrs; 200 ppm KNO_3 for 10 hrs; 400 ppm KNO_3 for 6 hrs; 400 ppm KNO_3 for 8 hrs; 400 ppm KNO_3 for 10 hrs and dry seeds as control in laboratory condition. From the experiment, it can be concluded that 100 ppm KNO_3 soaking for 8 hrs was the best performer than other priming materials as it was highest performer in germination percentage (96.30), seedling fresh weight (1.84 g), seedling dry weight (0.14g), seedling Vigour Index-I (2013.08), mean germination time (3.15 days), time to 50 % germination (2.45 days) and germination index (40.453).

Keywords: Germination, potassium nitrate, priming, vigour.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a self-pollinated crop. It is diploid (2n=16) species with genome size 1C=740 Mbp (Arumuganathan and Earle 1991) and belonging to sub family Papilionaceae of the family *Leguminaceae* (Poehlman and Sleper 1995). Chickpea is a cool season legume crop and is grown in several countries worldwide as a food source. Seed is the main edible part of the plant and is a rich source of protein (23.3-28.9%), carbohydrates (61.5%), fats (4.5%) and minerals (phosphorus, calcium, magnesium, iron, zinc). It consists of remarkable attributes like wider climatic adaptation, low production cost and having an ability to be applied in crop alternation and atmospheric nitrogen fixation. Seeds undergo deterioration at various levels during storage resulting in decline in a vigour and viability (Bordolui *et al.*, 2015). Seed priming is one of the most important physiological methods which improves the seed performance and provides faster and synchronized germination (Chakraborty and Bordolui 2021). The primed seeds give earlier, more uniform and sometime greater germination and seedling establishment and growth (Bradford, 1986). It is a physiological strategy that involves soaking of seeds in a solution of a specific priming agent followed by drying of seeds that initiates germination related process. This has been recognized as an important technology to obtain good germination, rapid development and improved yields in some field crops. Moreover, priming is a simple, low-cost and low-risk technology which would be appropriate for all farmers, irrespective of their socio-economic status. The fundamental principle is that sowing of primed seed reduces the time of germination and may allow germination and growth of seedling under adverse soil and environmental conditions (Farooq *et al.*, 2008). Besides better germination and seedling growth, farmers have reported that primed seeds grew more vigorously, flowered earlier and yielded higher (Harris *et al.*, 2001). By seed priming, maintenance of viability, vigour, and increase the storability of seeds is very much essential (Bordolui *et al.*, 2018). The effectiveness of the priming with simple salt solution, perhaps, depends both on the osmotic potential and the chemical nature of the salt species used. It is reported that nitrate containing compounds may function more efficiently than other salts as priming agents. So, our objective to determination of appropriate concentration and duration of KNO_3 is essential for priming of chickpea seed. Keeping the above points, the present investigation was carried out after seed prime with KNO_3 in different concentrations and durations, and dry seeds as control in laboratory condition on germination, seedling growth and vigour status.

MATERIALS AND METHODS

The laboratory experiment was carried out in seed testing laboratory, Department of Seed Science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during 2021 following Complete Randomized Design with three replications. Chickpea (Anuradha) was collected from AICRP pulses in Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal for this investigation.

Seed priming. Seed priming was done with 50 ppm KNO_3 for 6 hrs (T_1); 50 ppm KNO_3 for 8 hours (T_2); 50 ppm KNO_3 for 10 hours (T_3); 100 ppm KNO_3 for 6 hrs (T_4); 100 ppm KNO_3 for 8 hrs (T_5); 100 ppm KNO_3 for 10 hours (T_6); 200 ppm KNO_3 for 6 hours (T_7); 200 ppm KNO_3 for 8 hrs (T_8); 200 ppm KNO_3 for 10 hrs (T_9); 400 ppm KNO_3 for 6 hrs (T_{10}); 400 ppm KNO_3 for 8 hrs (T_{11}); 400 ppm KNO_3 for 10 hrs (T_{12}). Non-primed seeds were the control (T_0).

Germination Parameters

Time to 50% germination. According to Association of Official Seed Analysis (1983) number of seeds germinated was recorded in daily basis. The time to obtain 50% germination (T_{50}) was calculated according to the following formulae given by Coolbear *et al*. (1984) which was modified by Farooq *et al*. (2005).

$$T_{50} = t_i + \frac{\left(\frac{N}{2} - n_i\right)(t_j - t_i)}{(n_j - n_i)}$$

Where, N stands for final number of germination and n_i, n_j are cumulative number of seeds germinated by adjacent counts at times t_i and t_j when $n_i < N/2 < n_j$.

Mean germination time (MGT)

Mean germination time (MGT) was calculated with the following equation suggested by Ellis and Roberts (1981).

$$MGT = \frac{\sum D_n}{\sum n}$$

Where n indicates the number of seeds germinated on day D, and D is the number of days counted from the beginning of germination.

Germination percentage. Germination percentage (G) was calculated as:

$$\frac{\text{Number of normal seedlings produced}}{\text{Total number of seeds used}} \times 100$$

Where, X is the number of normal seedlings produced and Y denotes total number of seeds taken for germination (ISTA, 1996). It is expressed in percentage.

Germination index (GI). Germination index (GI) was calculated as described in the Association of Official Seed Analysts (AOSA, 1990) as the following formulae:

$$GI = \frac{\text{No. of germinated seeds}}{\text{Day of fi count}} + - - - - + \frac{\text{No. of germinated seeds}}{\text{Day of last count}}$$

Germination Energy. According to Ruan *et al*. (2002) energy of germination (GE) should be recorded at 4^{th} day after planting. It is the percentage of germinating seeds 4 days after planting relative to the total number of seeds tested.

Seedling parameters. Root lengths and shoot lengths of ten seedlings were measured at 8 days after germination by glass plate method in the laboratory with the help of a scale and graph paper and average was made out, expressed in centimetre (cm). Fresh weight of ten seedlings was measured with the help of a digital balance. Then seedlings were dried at 60-70 °C for two hours in hot air oven and weighed in a digital balance. Both seedling fresh weight and dry weight are expressed in gram (g).

Vigour index. Vigour index (VI) was calculated by using the formula suggested by Abdul Baki and Anderson (1973): VI= G X L

Where, 'G' indicates germination percentage and 'L' denotes average seedling length (cm)

RESULT AND DISCUSSION

Germination Index. Germination Index significantly varied due to priming with different duration and concentration of KNO_3. Lowest Germination index was observed in control (23.060) preceded by T_{12}, T_7 and T_6. While, T_5 (40.453) showed the highest germination index followed by T_2, T_4 and T_1. But, non-significant difference was observed in between T_6, T_7 and T_{10}; T_3, T_9 and T_{11}; T_6 and T_9. Similar type of result was observed by Patil *et al*. (2018); Ray and Bordolui (2022a).

Root length (cm). Significant difference was observed in root length for potassium nitrate priming. Maximum seedling root length was observed for T_8 (6.26 cm) followed by T_3 and T_9 respectively, while it was minimum for T_0 (4.00 cm) (Table 1). Although T_1, T_4 and T_5; T_3, T_8 and T_9; T_6 and T_{11}; T_0 and T_{12} showed non-significant difference among themselves. Root and shoot length increased in seeds due to priming as compared to non-primed seeds reported by Demir and Oztokat (2003); Ray and Bordolui (2022b).

Shoot length (cm). Considering shoot length, the longest seedling shoot length was recorded for T_1 (17.44 cm) followed by T_5 and T_6 while shortest shoot length was observed in Control (7.56 cm) preceded byT_3 and T_{10}. Significant difference was noted for shoot length in overall though non- significant difference was observed in between T_2, T_9 and T_{12}; T_6 and T_{11}; T_7 and T_{10}. The result corroborates the findings of Chang-Zheng *et al*. (2002) who reported that rice seed treated with mixed salt solution germinated significantly more rapidly than unprimed seed.

Fresh weight (g). Significant difference was observed in fresh weight after potassium nitrate priming. Highest seedling fresh weight was observed for T_5 (1.84 g) followed by T_{10} and T_3 while lowest was noted in T_7 (0.85 g) preceded by T_0 and T_2 respectively. But non-significant difference was noticed in between T_6 and T_{11}; T_{11} and T_9; T4 and T_{12}; T_5 and T_8.

Dry weight (g). In case of dry weight, it was significantly varied due to priming with different duration and concentration of KNO_3. Maximum seedling dry weight was noticed for T_5 (0.14 g) followed by T_{11} and T_6 respectively while minimum was noticed for control (0.07) preceded by T_2 and T_9 respectively. Although non-significant difference was observed in between T_0, T_2 and T_7; T_1, T_3, T_4, T_6, T_{10} and T_{12}; T_{10} and T_{11}; T_6 and T_8. Mohammadi (2009) on soybean (*Glycine max* L.) in field and laboratorial studies found that seed primed with potassium nitrate increased germination percentage (GP), seedling fresh weight and seedling dry weight as compared to control.

Table 1: Effect of priming on germination index, root length, shoot length, fresh weight and dry weight of chickpea.

Treatment	Germination Index	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)
T_0	23.060	4.00	7.56	0.91	0.07
T_1	29.897	4.63	17.44	1.23	0.11
T_2	37.917	5.22	11.87	0.93	0.08
T_3	27.800	6.17	9.58	1.57	0.10
T_4	31.163	4.61	14.12	1.36	0.10
T_5	40.453	4.65	16.26	1.84	0.14
T_6	26.740	5.83	15.44	1.54	0.12
T_7	26.207	4.51	11.06	0.85	0.08
T_8	29.633	6.26	13.93	1.84	0.13
T_9	27.480	6.07	12.29	1.22	0.10
T_{10}	26.550	4.51	10.90	1.62	0.12
T_{11}	27.617	5.57	15.08	1.54	0.13
T_{12}	24.677	4.06	12.29	1.35	0.10
SEm (±)	0.254	**0.140**	**0.169**	**0.059**	**0.01**
LSD (0.05)	0.744	**0.408**	**0.495**	**0.172**	**0.02**

Note: T_0 = Control, T_1= 50 ppm KNO_3 for 6 hrs, T_2 = 50 ppm KNO_3 for 8 hrs, T_3 = 50 ppm KNO_3 for 10 hrs, T_4 = 100 ppm KNO_3 for 6 hrs, T_5 = 100 ppm KNO_3 for 8 hrs, T_6 = 100 ppm KNO_3 for 10 hrs T_7 = 200 ppm KNO_3 for 6 hrs, T_8 = 200 ppm KNO_3 for 8 hrs, T_9 = 200 ppm KNO_3 for 10 hrs, T_{10}= 400 ppm KNO_3 for 6 hrs, T_{11}=400 ppm KNO_3 for 8 hrs, T_{12}=400 ppm KNO_3 for 10 hrs.

Germination Percentage. Significant difference was observed in germination percentage. Among the priming treatments, with different duration and concentration of KNO_3, T_5 (96.30 %) recorded highest germination percentage followed by T_2 and T_8. While lowest germination percentage was recorded for T_0 (85.83) preceded by T_3, T_{10} and T_6 respectively. But, non-significant difference was observed in betweenT_1, T_4, T_3, T_6, T_{10}, T_{11} and T_{12}; T_7, T_8, T_9 and T_{11}. This result is in agreement with Mohammadi and Amiri (2010) who reported that seed priming with nitrate solutions led to improved germination rate.

Vigour Index. Considering vigour index, maximum value was calculated for T_5 (2013.08) followed by T_1 and T_8 respectively; minimum vigour index was noted for T_0 (992.18) preceded by T_{10} and T_3. Although, vigour index was significantly varied, but some non – significant difference was also noticed in between T_1 and T_5; T_3, T_7, T_{10} and T_{12}; T_2, T_4 and T_9; T_6, T_8 and T_{11}. Mohammadi (2009) reported similar kind of observation that soaking of soybean (*Glycine max*) seed in potassium nitrate had the best effect on germination and seed vigour with late sowing. Ray and Bordolui (2020)

Time to 50 % germination (days). Significant responses were noticed in the priming treatment with different duration and concentration of potassium nitrate under laboratory condition. Minimum time to 50% germination was recorded in T_5 (2.45 days) followed by T_4 and T_3. While, maximum time to 50% germination was observed for T_0 (3.55 days) preceded by T_{12} and T_7. Although, time to 50% germination was significantly varied, but some non significant difference was also noticed in between T_1, T_3, T_4, T_8 and T_{11}; T_2, T_6, T_8, T_9, T_{10} and T_{11}. Dezfuli *et al*. (2008) observed similar type of result in maize.

Mean germination time (days). Considering Mean germination time T_5 (3.15 days) had the shortest mean germination time preceded by T_2 and T_1. While maximum mean germination time was noticed in T_0 (4.40 days) followed by T_{12}. Though significant difference was observed in mean germination time but some non –significant difference was also noticed in between T_6, T_7, T_9, T_{10} and T_{11}; T_7, T_8, T_9, T_{11} and T_{12}; T_1, T_2, T_4 and T_6; T_3 and T_4. Similar kind of observation was noted by Vadez *et al*. (1996) in bean.

Germination energy (%). Significant difference was observed in germination energy for potassium nitrate. The maximum energy of germination was recorded in T_2 (76.09) followed by T_{11}, T_4 and T_6 while it was minimum for T_0 (51.57) preceded by T_7 and T_{12}. Seed priming treatments enhanced the energy of germination over that of untreated seeds and maximum energy of germination was recorded with hydro-priming in rice (Mahajan *et al*., 2011). Low vigour seeds of hybrid sunflower showed significant decrease in mean germination time and increase in germination index as well as germination energy over non-primed low vigour seeds after priming with KH_2PO_4 (Kausar *et al*, 2009).

Table 2: Effect of priming on germination percentage, vigour index, Time to 50 % germination, Mean germination time and Germination energy of chickpea.

Treatment	Germination Percentage (Tr value)	Vigour Index	Time to 50 % germination (days)	Mean germination time (days)	Germination energy (%) (Tr value)
T_0	85.83 (67.86)	992.18	3.55	4.40	51.57 (45.88)
T_1	89.33 (70.93)	1971.34	2.63	3.45	60.16 (50.84)
T_2	96.07 (78.62)	1641.81	2.88	3.40	76.09 (60.70)
T_3	88.57 (70.22)	1394.51	2.55	3.73	59.28 (50.33)
T_4	89.40 (70.99)	1674.53	2.54	3.46	68.84 (56.05)
T_5	96.30 (78.93)	2013.08	2.45	3.15	63.42 (52.76)
T_6	88.90 (70.54)	1890.17	2.83	3.66	68.04 (55.56)
T_7	92.80 (74.49)	1444.27	3.04	3.88	57.60 (49.35)
T_8	94.24 (76.12)	1902.20	2.74	3.96	65.60 (54.07)
T_9	92.47 (74.07)	1697.07	2.96	3.87	59.18 (50.27)
T_{10}	88.73 (70.40)	1367.15	2.82	3.60	59.73 (50.59)
T_{11}	91.03 (72.60)	1880.57	2.79	3.69	69.37 (56.37)
T_{12}	89.13 (70.73)	1457.35	3.34	3.94	57.69 (49.40)
SEm (±)	**0.774**	**23.964**	**0.066**	**0.095**	**0.298**
LSD (0.05)	**2.263**	**70.048**	**0.193**	**0.279**	**0.872**

Note: T_0 = Control, T_1= 50 ppm KNO_3 for 6 hrs, T_2 = 50 ppm KNO_3 for 8 hrs, T_3 = 50 ppm KNO_3 for 10 hrs, T_4 = 100 ppm KNO_3 for 6 hrs, T_5 = 100 ppm KNO_3 for 8 hrs, T_6 = 100 ppm KNO_3 for 10 hrs T_7 = 200 ppm KNO_3 for 6 hrs, T_8 = 200 ppm KNO_3 for 8 hrs, T_9 = 200 ppm KNO_3 for 10 hrs, T_{10}= 400 ppm KNO_3 for 6 hrs, T_{11}=400 ppm KNO_3 for 8 hrs, T_{12}=400 ppm KNO_3 for 10 hrs.

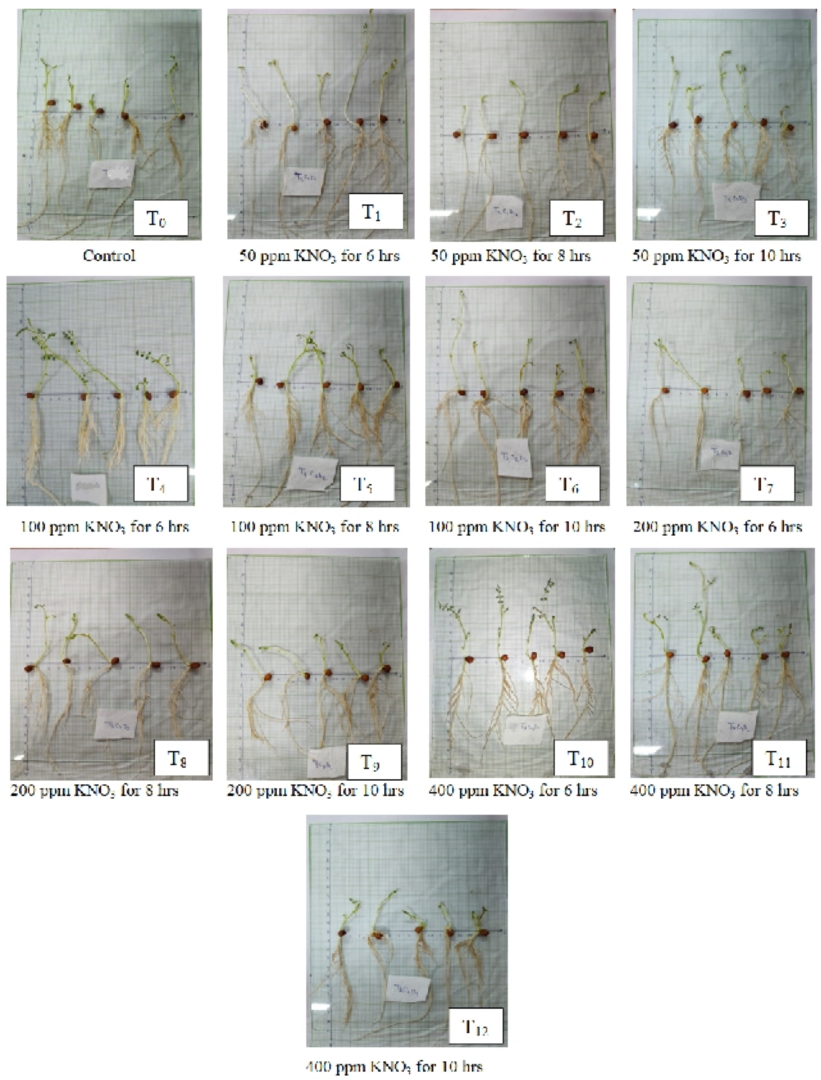

Fig. 1. Evaluation of seedling vigour under laboratory condition

CONCLUSION

Seeds of chickpea were treated with various concentration and duration of potassium nitrate recorded higher seed quality parameters compared to control. Seeds treated with KNO_3 100 ppm observed the significant higher than other priming concentrations and durations. It can be concluded that among all the treatments, KNO_3 100 ppm for soaking 8 hrs showed significant performance for seed quality parameter like germination percentage (96.30), seedling fresh weight (1.84 g), seedling dry weight (0.14g), seedling vigour Index-I (2013.08), mean germination time (3.15 days), time to 50 % germination (2.45 days) and germination index (40.453). Therefore, as pre-sowing treatment KNO_3 100 ppm with a duration of 8 hrs is recommended for treating chickpea seed for better seedling establishment.

FUTURE SCOPE

There is a scope to study the priming effect of other priming materials in chickpea.

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Conflict of Interests. None.

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