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# Comparative efficacy of priming treatments and storage periods in overcoming seed dormancy in round gourd (*Praecitrullus fistulosus* (Stocks) Pangalo)

**Tavisha Singh[1*], Seema Bedi[1] and Rajinder Singh[2]**

*[1]Department of Botany, Punjab Agricultural University, Ludhiana-141004, India. [2]Associate Director (Seeds), Punjab Agricultural University, Ludhiana-141004, India. *E-mail: tavisha-bot@pau.edu*

## Abstract

Owing to its hard seed coat, the seeds of *Praecitrullus fistulosus* exhibit dormancy which impairs the germinability and subsequent seed establishment. To overcome this dormancy, the seeds are required to be stored for a minimum of 45 days after harvest (DAH). In north Indian plains, round gourd seeds are harvested in mid-June and are required to be sown immediately in June-July. Therefore, priming treatments were employed to overcome seed dormancy in a short interval. To assess the effect of various priming treatments in overcoming dormancy, the seeds were stored at room temperature for various durations and at the end of the storage period, the seeds were primed by soaking in solutions of $GA_3$ (150 µgmL$^{-1}$, 500 µgmL$^{-1}$,1000 µgmL$^{-1}$ gibberellic acid), cytokinin (150 µgmL$^{-1}$, 500 µgmL$^{-1}$,1000 µgmL$^{-1}$kinetin), ethylene (150, 500, 1000 ethrel), $KNO_3$ (150 and 500 µgmL$^{-1}$), $HNO_3$ (150 and 500 µlL$^{-1}$) and water, at 25$^0$C for 12 hours and 24 hours, respectively. Among all the priming treatments, 500 µgmL$^{-1}$ $KNO_3$ for 24 h enhanced percentage germination to more than 60 per cent in freshly harvested seeds to more than 80 per cent in seeds stored for 15 DAH. It also enhanced the length of seedling, vigour index (SVI-I and SVI-II), and coefficient of rate of germination (CRG) with a reduction in the mean days taken for germination (MDG).

**Key words**: Gibberellic acid, seed coat, harvested seeds, $KNO_3$, mean days to germination, *Praecitrullus fistulosus,* priming, round gourd, seed dormancy, seed germination, seedling vigour index, storage duration

## Introduction

The fruits of *Praecitrullus fistulosus* has numerous medicinal and nutritional properties and is known as a miraculous crop (Gautam and Shivhare, 2011). It is a tropical vegetable of the family Cucurbitaceae consumed extensively in subtropical countries including the Indian subcontinent. It is cultivated in India over an area of 0.53 million ha with an annual production of 5.14 million tonnes (FAO, 20221-22).

In the plains of North India, round gourd cultivation occurs during either the dry season (February-March) or the rainy season (June-July). Seeds for round gourd are typically collected from crops sown in February-March. Those harvested in mid-June need to be promptly planted during June-July. However, a significant challenge in round gourd production is seed dormancy immediately after harvesting, primarily due to the tough seed coat. Additionally, seeds from crops sown in June-July are prone to cucumber green mottle mosaic virus but are suitable for planting purposes (Asad et al., 2022).

According to Indian minimum seed certification standards (IMSCS), the germination percentage for freshly harvested cucurbit seeds is set at 60%. This suggests that achieving a higher germination percentage in these crops is challenging. The germination rate decreases in newly harvested cucurbit seeds. To enhance germination and emergence, priming treatments should be used prior to sowing in the field (Muruli et al., 2016; Rhaman et al., 2020). Seed priming techniques expedite the metabolic processes prior to germination, leading to quicker germination and seedling growth. Discovering appropriate seed priming techniques will allow Punjab farmers to utilize seeds right after harvesting, eliminating the need to wait for the natural dormancy release process.

Hence, this study aimed to examine how various priming treatments impact the germination and vigor of seeds stored for different periods. This knowledge holds significance for both farmers and the seed industry, allowing them to expedite seed propagation post-harvest without the need for prolonged storage to naturally overcome dormancy.

## Materials and methods

The seeds were obtained from spring season crop harvested in mid-June in the years 2018 and 2019, respectively. The freshly harvested seeds were stored in poly bags and placed at room temperature at 25± 2$^o$C for 60 days after harvesting.

**Priming treatments and germination studies:** Germination studies were carried out on seed lots drawn from the store seeds at 15-day intervals, viz., 0 day, 15 days, 30 days, 45 days and 60 days respectively. The drawn seed lot was surface sterilized with mercuric chloride (0.1%) for one minute followed by rinsing twice in distilled water and then subjected to priming treatment in an appropriate solution. The seed priming treatments included: $GA_3$ (150 µgmL$^{-1}$, 500 µgmL$^{-1}$, 1000 µgmL$^{-1}$ gibberellic acid), cytokinin (150 µgmL$^{-1}$, 500 µgmL$^{-1}$,1000 µgmL$^{-1}$ kinetin), ethylene (150 µlL$^{-1}$,500 µlL$^{-1}$,1000 µlL$^{-1}$ethrel), $KNO_3$ (150 µgmL$^{-1}$, 500 µgmL$^{-1}$), $HNO_3$ (150 µlL$^{-1}$, 500 µlL$^{-1}$) and water (hydropriming).

Approximately 10 mL of respective priming solution was added to each Petri-dish to saturate the Whatmann paper. Thereafter, another 2.0 mL of respective solution was added to each Petri-dish. The seeds (10 per Petridish) were imbibed in these solutions for 12 h and 24 h respectively at 25± 2°C. Thereafter, the seeds were gently removed from priming solutions, blotted dry and kept for germination.

Germination studies were conducted under laboratory conditions. The seeds were germinated in Petri-dishes (9.0 cm) lined with two layers of Whatman No.1 filter paper (3.5 X 16 cm) and moistened with distilled water The seeds were observed visually every day and re-moistened with water or respective solutions as required. Petri-plates were observed daily for 10 days for germination. Radicle length of 2 mm or more was used as a germination criterion. Primary root length and shoot length were measured at the end of 10$^{th}$ day and expressed in centimetres. Ten seedlings were selected at random, gently blotted dry and then fresh weight was recorded and expressed in grams. For dry weight determination, seedlings which were used for recording fresh weight were dried in oven at 60$^0$C for 3 days and their weight was recorded.

**Statistical analysis:** The experiment was laid out as split plot design with three replications where storage durations were assigned as the main plot and seed priming treatments as subplot (Singh *et al.,* 1998). The data obtained were subjected to analysis of variance by CRD with CPCS1 statistical software.

## Results and discussion

**Germination percentage (%):** Round gourd seeds remained dormant even 30 days after harvest and the Indian minimum seed certification standards (IMSCS) for germination percentage are met 45 days after harvest (Table 1). Various priming treatments

Table 1. Effect of different storage durations and priming treatments on germination percentage and seedling length in round gourd under lab conditions

| Treatment | Germination percentage (pooled data) | | | | | | Seedling length (cm) (pooled data) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean |
| $T_1$: ($GA_3$150µgmL$^{-1}$/12 h) | 44.67 | 77.00 | 77.63 | 85.69 | 95.55 | 76.11 | 27.11 | 30.25 | 32.25 | 33.87 | 36.69 | 33.27 |
| $T_{2:}$ ($GA_3$150µgmL$^{-1}$/24 h) | 45.50 | 83.40 | 78.33 | 84.36 | 95.68 | 77.45 | 27.15 | 30.28 | 32.31 | 35.53 | 36.22 | 33.59 |
| $T_{3:}$ ($GA_3$500µgmL$^{-1}$/12 h) | 46.83 | 84.33 | 85.05 | 85.22 | 97.45 | 79.78 | 27.35 | 30.44 | 35.27 | 35.24 | 37.72 | 34.67 |
| $T_{4:}$ ($GA_3$500µgmL$^{-1}$/24 h) | 48.83 | 77.43 | 85.40 | 85.39 | 97.67 | 78.94 | 32.39 | 34.45 | 35.33 | 36.65 | 37.96 | 36.10 |
| $T_{5:}$ ($GA_3$1000µgmL$^{-1}$/12 h) | 53.67 | 76.55 | 83.33 | 86.88 | 100.00 | 80.09 | 33.00 | 35.04 | 36.66 | 38.55 | 40.15 | 37.60 |
| $T_{6:}$ ($GA_3$1000µgmL$^{-1}$/24 h) | 56.50 | 73.55 | 82.26 | 84.59 | 100.00 | 79.38 | 33.17 | 35.19 | 36.49 | 38.03 | 40.22 | 37.48 |
| $T_{7:}$ (Cyt150µgmL$^{-1}$/12 h) | 29.97 | 70.23 | 75.27 | 82.10 | 85.41 | 68.60 | 21.22 | 23.27 | 28.19 | 29.34 | 32.59 | 28.35 |
| $T_{8:}$ (Cyt150µgmL$^{-1}$/24 h) | 31.50 | 73.53 | 77.33 | 82.00 | 85.41 | 69.95 | 22.51 | 24.55 | 28.63 | 29.97 | 34.33 | 29.37 |
| $T_{9:}$ (Cyt500µgmL$^{-1}$/12 h) | 35.17 | 78.44 | 81.43 | 82.12 | 86.44 | 72.72 | 27.22 | 30.24 | 31.22 | 33.11 | 33.25 | 31.96 |
| $T_{10:}$ (Cyt500µgmL$^{-1}$/24 h) | 36.07 | 76.50 | 85.36 | 83.06 | 86.77 | 73.55 | 27.19 | 33.22 | 35.11 | 35.22 | 36.34 | 34.97 |
| $T_{11:}$(Cyt1000µgmL$^{-1}$/12 h) | 39.33 | 64.26 | 61.43 | 68.02 | 72.22 | 61.05 | 31.19 | 34.22 | 35.16 | 36.04 | 37.22 | 35.66 |
| $T_{12:}$(Cyt1000µgmL$^{-1}$/24 h) | 39.00 | 64.29 | 61.57 | 72.11 | 73.06 | 62.01 | 31.59 | 34.66 | 35.78 | 36.58 | 38.27 | 36.32 |
| $T_{13:}$(Ethrel 150µlL$^{-1}$/12 h) | 25.00 | 53.69 | 64.23 | 71.43 | 73.33 | 57.54 | 21.32 | 23.33 | 25.55 | 26.38 | 26.63 | 25.47 |
| $T_{14:}$(Ethrel 150µlL$^{-1}$/24 h) | 25.70 | 52.03 | 65.66 | 71.27 | 73.55 | 57.64 | 21.67 | 23.77 | 25.22 | 26.81 | 27.33 | 25.78 |
| $T_{15:}$(Ethrel 500µlL$^{-1}$/12 h) | 26.30 | 52.23 | 67.37 | 73.17 | 75.22 | 58.86 | 22.31 | 24.33 | 26.14 | 27.66 | 28.98 | 26.78 |
| $T_{16:}$(Ethrel 500µlL$^{-1}$/24 h) | 26.53 | 51.50 | 67.05 | 73.33 | 75.22 | 58.73 | 22.38 | 24.43 | 26.59 | 27.51 | 28.68 | 26.80 |
| $T_{17:}$(Ethrel 1000µlL$^{-1}$/12 h) | 28.00 | 51.50 | 67.27 | 73.47 | 75.56 | 59.16 | 20.19 | 22.22 | 25.43 | 26.17 | 27.25 | 25.27 |
| $T_{18:}$(Ethrel 1000µlL$^{-1}$/24 h) | 31.00 | 52.53 | 67.44 | 73.55 | 75.22 | 59.95 | 20.77 | 22.83 | 25.44 | 26.18 | 27.26 | 25.43 |
| $T_{19:}$($KNO_3$150µgmL$^{-1}$/12 h) | 48.67 | 82.63 | 86.55 | 95.25 | 100.00 | 82.62 | 38.77 | 41.92 | 45.94 | 46.05 | 46.36 | 45.07 |
| $T_{20:}$($KNO_3$150µgmL$^{-1}$/24 h) | 50.33 | 84.27 | 86.82 | 95.67 | 100.00 | 83.42 | 38.06 | 42.15 | 44.15 | 46.37 | 46.84 | 44.88 |
| $T_{21:}$($KNO_3$500µgmL$^{-1}$/12 h) | 57.00 | 85.93 | 88.50 | 100.00 | 100.00 | 86.29 | 40.66 | 43.72 | 44.14 | 46.57 | 48.66 | 45.77 |
| $T_{22:}$($KNO_3$500µgmL$^{-1}$/24 h) | 66.83 | 86.07 | 92.33 | 100.00 | 100.00 | 89.05 | 40.44 | 44.57 | 46.29 | 46.48 | 48.84 | 46.55 |
| $T_{23:}$($HNO_3$150µlL$^{-1}$/12 h) | 43.67 | 76.56 | 84.45) | 93.56 | 100.00 | 79.65 | 38.11 | 42.17 | 45.98 | 46.44 | 46.67 | 45.32 |
| $T_{24:}$($HNO_3$150µlL$^{-1}$/24 h) | 44.83 | 76.73 | 85.83 | 93.44 | 100.00 | 80.17 | 38.29 | 43.33 | 43.43 | 43.15 | 43.06 | 43.24 |
| $T_{25:}$($HNO_3$500µlL$^{-1}$/12 h) | 42.00 | 81.33 | 86.97 | 95.78 | 100.00 | 81.22 | 39.07 | 43.11 | 44.66 | 45.63 | 46.55 | 44.99 |
| $T_{26:}$($HNO_3$500µlL$^{-1}$/24 h) | 48.67 | 81.99 | 87.95 | 95.89 | 100.00 | 82.90 | 39.38 | 42.41 | 44.92 | 46.72 | 46.14 | 45.05 |
| $T_{27:}$Hydration | 44.67 | 70.33 | 80.00 | 85.77 | 93.85 | 74.92 | 28.16 | 33.22 | 35.95 | 36.98 | 37.19 | 35.84 |
| $T_{28:}$ Control | 22.67 | 41.66 | 50.21 | 66.33 | 76.11 | 51.19 | 15.77 | 16.97 | 17.16 | 17.36 | 20.58 | 18.74 |
| Mean | 40.68 | 70.73 | 77.25 | 83.55 | 89.02 | | 29.52 | 32.62 | 34.62 | 35.73 | 37.07 | |
| CD at *P*=0.05 (D) | | 1.86 | | | | | | 0.063 | | | | |
| CD at *P*=0.05 (T) | | 2.56 | | | | | | 0.102 | | | | |
| CD at *P*=0.05 (D X T) | | 4.89 | | | | | | 0.200 | | | | |

Data presented as mean values, where D indicates Days and T indicates Treatment whereas D × T indicates interaction between the variables were employed for improving the germination of the seeds. Among all the treatments, priming with 500 µgmL$^{-1}$ $KNO_3$ for 24 h ($T_{22}$) was the only treatment that improved germination to the IMSC standards even in the freshly harvested seeds (0 DAH). After 45 DAH the 60 per cent germination barrier was naturally crossed even without priming treatments. However, priming treatments are effective in further improving the germination of round gourd seeds over unprimed control. Priming with $KNO_3$ (500 µgmL$^{-1}$) lead to 100% germination. A similar increase in germination percentage in cucurbit seeds primed with $KNO_3$ solution has been reported in ash gourd (Rahman *et al.,* 2014), *Cucurbita pepo* (Gharahlar *et al.,* 2009).

**Seedling length (cm):** Maximum seedling length was recorded in seedlings obtained from both unprimed (control) and primed seeds that had been stored for 60 DAH (Table 1). Priming treatments further enhanced seedling length. However, priming treatments marked significant increase in seedling length when subjected to $KNO_3$ over rest of priming treatments. Similarly, in seeds stored for 45 and 60 DAH and subjected to priming treatments, significant increase in seedling length was recorded. Likewise, increased in shoot length when primed with $KNO_3$ solution was recorded in summer squash (Gharahlar *et al.,* 2009), watermelon (Barbosa *et al.,* 2016) and *Cucumis sativus* (Okon and Okon, 2017) seeds. Seed priming with $GA_3$ also had beneficial effect on improving seedling growth in a range of plant species (Kandil *et al.,* 2014).

**Coefficient of rate of germination (CRG) and Mean days to germination (MDG):** Germination rate in a seed lot measures the length of time it takes a seed to germinate. Seeds of round gourd exhibited maximum value of coefficient of rate of germination when subjected to priming with 500 µgmL$^{-1}$ $KNO_3$ for 12 and 24 h respectively ($T_{21}$ and $T_{22}$) (Table 2). The storage durations had

Table 2. Effect of different storage durations and priming treatments on coefficient of rate of germination and mean days to germination in round gourd under lab conditions

| Treatments | Coefficient of rate of germination (CRG) (pooled data) | | | | | | Mean days to germination (MDG) (pooled data) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean |
| $T_1$: ($GA_3$150µgmL$^{-1}$/12 h) | 47.39 | 45.05 | 45.05 | 45.05 | 45.05 | 45.52 | 2.12 | 2.22 | 2.22 | 2.22 | 2.22 | 2.22 |
| $T_2$: ($GA_3$150µgmL$^{-1}$/24 h) | 45.25 | 45.05 | 44.64 | 44.64 | 43.86 | 44.69 | 2.22 | 2.21 | 2.24 | 2.23 | 2.28 | 2.24 |
| $T_3$: ($GA_3$500µgmL$^{-1}$/12 h) | 45.05 | 44.84 | 44.25 | 44.25 | 44.25 | 44.53 | 2.22 | 2.23 | 2.26 | 2.26 | 2.25 | 2.25 |
| $T_4$: ($GA_3$500µgmL$^{-1}$/24 h) | 44.64 | 44.84 | 44.25 | 44.05 | 44.05 | 44.37 | 2.24 | 2.23 | 2.23 | 2.27 | 2.18 | 2.23 |
| $T_5$: ($GA_3$1000µgmL$^{-1}$/12 h) | 44.64 | 42.92 | 42.74 | 42.55 | 42.37 | 43.04 | 2.24 | 2.34 | 2.31 | 2.35 | 2.24 | 2.31 |
| $T_6$: ($GA_3$1000µgmL$^{-1}$/24 h) | 44.64 | 44.44 | 42.74 | 42.37 | 42.19 | 43.28 | 2.24 | 2.25 | 2.33 | 2.36 | 2.22 | 2.29 |
| $T_7$: (Cyt150µgmL$^{-1}$/12 h) | 30.96 | 30.77 | 30.77 | 30.58 | 30.39 | 30.69 | 3.22 | 3.24 | 3.22 | 3.27 | 3.15 | 3.22 |
| $T_8$: (Cyt150µgmL$^{-1}$/24 h) | 30.96 | 30.77 | 30.77 | 30.58 | 30.39 | 30.69 | 3.23 | 3.24 | 3.25 | 3.27 | 3.13 | 3.22 |
| $T_9$: (Cyt500µgmL$^{-1}$/12 h) | 31.85 | 31.75 | 31.15 | 31.06 | 31.06 | 31.37 | 3.14 | 3.15 | 3.25 | 3.22 | 3.14 | 3.19 |
| $T_{10}$: (Cyt500µgmL$^{-1}$/24 h) | 31.85 | 31.75 | 31.15 | 31.06 | 31.06 | 31.37 | 3.15 | 3.15 | 3.15 | 3.16 | 3.22 | 3.17 |
| $T_{11}$:(Cyt1000µgmL$^{-1}$/12 h) | 31.15 | 31.06 | 32.05 | 30.77 | 30.76 | 31.16 | 3.20 | 3.21 | 3.10 | 3.26 | 3.24 | 3.20 |
| $T_{12}$:(Cyt1000µgmL$^{-1}$/24 h) | 31.15 | 31.15 | 32.05 | 30.77 | 30.76 | 31.18 | 3.21 | 3.19 | 3.12 | 3.22 | 3.21 | 3.19 |
| $T_{13}$:(Ethrel 150µlL$^{-1}$/12 h) | 29.94 | 30.03 | 29.94 | 30.77 | 30.49 | 30.23 | 3.33 | 3.32 | 3.31 | 3.25 | 3.28 | 3.29 |
| $T_{14}$:(Ethrel 150µlL$^{-1}$/24 h) | 30.39 | 30.03 | 29.94 | 29.85 | 29.85 | 30.01 | 3.26 | 3.26 | 3.12 | 3.22 | 3.25 | 3.21 |
| $T_{15}$:(Ethrel 500µlL$^{-1}$/12 h) | 30.03 | 29.94 | 29.94 | 29.85 | 29.85 | 29.92 | 3.34 | 3.36 | 3.32 | 3.25 | 3.23 | 3.29 |
| $T_{16}$:(Ethrel 500µlL$^{-1}$/24 h) | 30.03 | 30.21 | 30.12 | 30.77 | 29.85 | 30.19 | 3.31 | 3.29 | 3.17 | 3.25 | 3.26 | 3.24 |
| $T_{17}$:(Ethrel 1000µlL$^{-1}$/12 h) | 30.03 | 30.12 | 30.12 | 30.03 | 30.03 | 30.07 | 3.33 | 3.32 | 3.32 | 3.29 | 3.33 | 3.32 |
| $T_{18}$:(Ethrel 1000µlL$^{-1}$/24 h) | 30.03 | 30.12 | 30.12 | 29.85 | 29.49 | 29.92 | 3.33 | 3.31 | 3.22 | 3.35 | 3.39 | 3.32 |
| $T_{19}$:($KNO_3$150µgmL$^{-1}$/12 h) | 51.81 | 51.55 | 51.02 | 51.02 | 50.76 | 51.23 | 1.91 | 1.90 | 1.94 | 1.93 | 1.95 | 1.93 |
| $T_{20}$:($KNO_3$150µgmL$^{-1}$/24 h) | 51.81 | 51.55 | 51.02 | 51.02 | 50.76 | 51.23 | 1.91 | 1.91 | 1.91 | 1.91 | 1.93 | 1.92 |
| $T_{21}$:($KNO_3$500µgmL$^{-1}$/12 h) | 54.05 | 54.35 | 54.05 | 54.05 | 53.76 | 54.05 | 1.83 | 1.82 | 1.84 | 1.84 | 1.86 | 1.84 |
| $T_{22}$:($KNO_3$500µgmL$^{-1}$/24 h) | 54.05 | 54.05 | 54.05 | 54.05 | 53.76 | 53.99 | 1.82 | 1.80 | 1.84 | 1.82 | 1.84 | 1.83 |
| $T_{23}$:($HNO_3$150µlL$^{-1}$/12 h) | 51.28 | 51.28 | 51.28 | 51.28 | 50.76 | 51.18 | 1.95 | 1.95 | 1.95 | 1.95 | 1.94 | 1.95 |
| $T_{24}$:($HNO_3$150µlL$^{-1}$/24 h) | 52.08 | 52.08 | 52.08 | 51.81 | 51.02 | 51.81 | 1.91 | 1.92 | 1.92 | 1.93 | 1.92 | 1.92 |
| $T_{25}$:($HNO_3$500µlL$^{-1}$/12 h) | 54.05 | 53.76 | 53.48 | 53.48 | 53.48 | 53.65 | 1.85 | 1.85 | 1.89 | 1.85 | 1.87 | 1.87 |
| $T_{26}$:($HNO_3$500µlL$^{-1}$/24 h) | 54.05 | 53.48 | 53.48 | 53.48 | 53.48 | 53.59 | 1.85 | 1.85 | 1.85 | 1.83 | 1.86 | 1.85 |
| $T_{27}$:Hydration | 34.13 | 34.01 | 33.89 | 33.89 | 33.44 | 33.87 | 2.95 | 2.93 | 2.91 | 2.93 | 2.85 | 2.91 |
| $T_{28}$: Control | 30.21 | 29.33 | 28.49 | 27.32 | 26.59 | 28.39 | 3.39 | 3.45 | 3.51 | 3.66 | 3.79 | 3.60 |
| Mean | 40.27 | 40.01 | 39.81 | 39.65 | 39.41 | | 2.63 | 2.64 | 2.63 | 2.66 | 2.64 | |
| CD at $P$=0.05 (D) | | NS | | | | | | NS | | | | |
| CD at $P$=0.05 (T) | | 1.70 | | | | | | 0.13 | | | | |
| CD at $P$=0.05 (D X T) | | 3.40 | | | | | | 0.05 | | | | |

Data presented as mean values, where D indicates Days and T indicates Treatment whereas D × T indicates interaction between the variables

Table 3. Effect of different storage durations and priming treatments on seedling vigour index-I and seedling vigour index-II in round gourd under lab conditions

| Treatments | Seedling Vigour Index-I (SVI) (pooled data) | | | | | | Seedling Vigour Index-II (SVII) (pooled data) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean | 0 DAH | 15 DAH | 30 DAH | 45 DAH | 60 DAH | Mean |
| $T_1$: ($GA_3$150µgmL$^{-1}$/12 h) | 1.78 | 3.08 | 3.10 | 3.43 | 3.82 | 3.04 | 1211.00 | 2329.25 | 2503.57 | 2902.32 | 3505.73 | 2810.22 |
| $T_2$: ($GA_3$150µgmL$^{-1}$/24 h) | 1.82 | 3.34 | 3.13 | 3.37 | 3.82 | 3.09 | 1235.33 | 2525.35 | 2530.84 | 2997.31 | 3465.53 | 2879.76 |
| $T_3$: ($GA_3$500µgmL$^{-1}$/12 h) | 1.87 | 3.37 | 3.40 | 3.41 | 3.89 | 3.19 | 1280.80 | 2567.00 | 2999.71 | 3003.15 | 3675.81 | 3061.42 |
| $T_4$: ($GA_3$500µgmL$^{-1}$/24 h) | 1.95 | 3.09 | 3.42 | 3.42 | 3.91 | 3.16 | 1581.60 | 2667.46 | 3017.18 | 3129.54 | 3707.55 | 3130.43 |
| $T_5$: ($GA_3$1000µgmL$^{-1}$/12 h) | 2.15 | 3.06 | 3.33 | 3.48 | 4.00 | 3.20 | 1771.11 | 2682.31 | 3054.88 | 3349.22 | 4015.00 | 3275.35 |
| $T_6$: ($GA_3$1000µgmL$^{-1}$/24 h) | 2.26 | 2.94 | 3.29 | 3.38 | 4.00 | 3.17 | 1874.11 | 2588.23 | 3001.67 | 3216.96 | 4022.00 | 3207.22 |
| $T_7$: (Cyt150µgmL$^{-1}$/12 h) | 1.19 | 2.81 | 3.01 | 3.28 | 3.42 | 2.74 | 635.96 | 1634.25 | 2121.86 | 2408.81 | 2783.51 | 2237.11 |
| $T_8$: (Cyt150µgmL$^{-1}$/24 h) | 1.26 | 2.94 | 3.09 | 3.28 | 3.42 | 2.79 | 709.06 | 1805.16 | 2213.96 | 2457.54 | 2932.13 | 2352.20 |
| $T_9$: (Cyt500µgmL$^{-1}$/12 h) | 1.41 | 3.14 | 3.26 | 3.28 | 3.46 | 2.91 | 957.32 | 2372.03 | 2542.25 | 2718.99 | 2874.13 | 2626.85 |
| $T_{10}$: (Cyt500µgmL$^{-1}$/24 h) | 1.44 | 3.06 | 3.41 | 3.32 | 3.47 | 2.94 | 980.74 | 2541.33 | 2996.99 | 2925.37 | 3153.22 | 2904.23 |
| $T_{11}$:(Cyt1000µgmL$^{-1}$/12 h) | 1.57 | 2.57 | 2.46 | 2.72 | 2.89 | 2.44 | 1226.70 | 2198.98 | 2159.88 | 2451.44 | 2688.03 | 2374.58 |
| $T_{12}$:(Cyt1000µgmL$^{-1}$/24 h) | 1.56 | 2.57 | 2.46 | 2.88 | 2.92 | 2.47 | 1232.01 | 2228.29 | 2202.98 | 2637.78 | 2796.01 | 2466.27 |
| $T_{13}$:(Ethrel 150µlL$^{-1}$/12 h) | 1.00 | 2.15 | 2.57 | 2.86 | 2.93 | 2.30 | 533.00 | 1252.59 | 1641.08 | 1884.32 | 1952.78 | 1682.69 |
| $T_{14}$:(Ethrel 150µlL$^{-1}$/24 h) | 1.03 | 2.08 | 2.63 | 2.85 | 2.94 | 2.30 | 556.92 | 1236.75 | 1655.95 | 1910.75 | 2010.12 | 1703.39 |
| $T_{15}$:(Ethrel 500µlL$^{-1}$/12 h) | 1.05 | 2.09 | 2.69 | 2.93 | 3.01 | 2.35 | 586.75 | 1270.76 | 1761.05 | 2023.88 | 2179.88 | 1808.89 |
| $T_{16}$:(Ethrel 500µlL$^{-1}$/24 h) | 1.06 | 2.06 | 2.68 | 2.93 | 3.01 | 2.35 | 593.74 | 1258.15 | 1782.86 | 2017.31 | 2157.31 | 1803.91 |
| $T_{17}$:(Ethrel 1000µlL$^{-1}$/12 h) | 1.12 | 2.06 | 2.69 | 2.94 | 3.02 | 2.36 | 565.32 | 1144.33 | 1710.68 | 1922.71 | 2059.01 | 1709.18 |
| $T_{18}$:(Ethrel 1000µlL$^{-1}$/24 h) | 1.24 | 2.10 | 2.69 | 2.94 | 3.01 | 2.39 | 643.87 | 1199.26 | 1715.67 | 1925.54 | 2050.50 | 1722.74 |
| $T_{19}$:($KNO_3$150µgmL$^{-1}$/12 h) | 1.95 | 3.31 | 3.46 | 3.81 | 3.98 | 3.30 | 1886.94 | 3463.85 | 3976.12 | 4386.26 | 4636.00 | 4115.56 |
| $T_{20}$:($KNO_3$150µgmL$^{-1}$/24 h) | 2.01 | 3.37 | 3.47 | 3.83 | 3.99 | 3.33 | 1915.56 | 3551.98 | 3833.10 | 4429.52 | 4684.00 | 4124.65 |
| $T_{21}$:($KNO_3$500µgmL$^{-1}$/12 h) | 2.28 | 3.44 | 3.54 | 4.00 | 4.03 | 3.46 | 2317.62 | 3756.86 | 3906.39 | 4657.00 | 4866.00 | 4296.56 |
| $T_{22}$:($KNO_3$500µgmL$^{-1}$/24 h) | 2.67 | 3.44 | 3.69 | 4.00 | 4.04 | 3.57 | 2702.61 | 3836.14 | 4273.96 | 4648.00 | 4884.00 | 4410.53 |
| $T_{23}$:($HNO_3$150µlL$^{-1}$/12 h) | 1.75 | 3.06 | 3.37 | 3.74 | 3.88 | 3.16 | 1664.26 | 3228.54 | 3883.01 | 4344.93 | 4667.00 | 4030.87 |
| $T_{24}$:($HNO_3$150µlL$^{-1}$/24 h) | 1.79 | 3.07 | 3.43 | 3.74 | 3.88 | 3.18 | 1716.54 | 3324.71 | 3727.60 | 4031.94 | 4306.00 | 3847.56 |
| $T_{25}$:($HNO_3$500µlL$^{-1}$/12 h) | 1.68 | 3.25 | 3.48 | 3.83 | 3.96 | 3.24 | 1640.94 | 3506.14 | 3884.08 | 4370.44 | 4655.00 | 4103.92 |
| $T_{26}$:($HNO_3$500µlL$^{-1}$/24 h) | 1.95 | 3.28 | 3.52 | 3.84 | 3.96 | 3.31 | 1916.63 | 3477.20 | 3950.71 | 4479.98 | 4614.00 | 4130.47 |
| $T_{27}$:Hydration | 1.79 | 2.81 | 3.20 | 3.43 | 3.75 | 2.99 | 1257.91 | 2336.36 | 2876.00 | 3171.78 | 3490.28 | 2968.61 |
| $T_{28}$: Control | 0.91 | 1.67 | 2.01 | 2.65 | 3.04 | 2.07 | 357.51 | 831.95 | 865.62 | 1138.22 | 1545.15 | 1095.24 |
| Mean | 1.63 | 2.83 | 3.09 | 3.34 | 3.55 | | 1269.71 | 2386.26 | 2742.49 | 3055.04 | 3370.56 | |
| CD at $P$=0.05 (D) | | 0.06 | | | | | | 101.52 | | | | |
| CD at $P$=0.05 (T) | | 0.10 | | | | | | 198.40 | | | | |
| CD at $P$=0.05 (D X T) | | 0.20 | | | | | | 391.81 | | | | |

Data presented as mean values, where D indicates Days and T indicates Treatment whereas D × T indicates interaction between the variables

non-significant effect on coefficient rate of germination values. Similar results have been reported in the seeds of watermelon (Demir and Mavi, 2004), and summer squash (Gharahlar *et al.,* 2009). However, it has been found that priming has significant role in increasing the speed of germination *e.g.*, in bitter gourd (Mehta *et al.,* 2014), and cucumber (Mehta *et al.,* 2013) seeds. In the present study, seeds of round gourd when treated with 500 µgmL$^{-1}$ $KNO_3$ for 12 and 24 h, respectively ($T_{21}$ and $T_{22}$) resulted in minimum mean days to germination (Table 2). Similar observations were recorded in watermelon (Armin *et al.,* 2010) and cucumber (Mehta *et al.,* 2013) seeds when primed in $KNO_3$ solution which resulted in decreased mean days to germination. The rapid germination of treated seeds is attributable to a higher rate of cell division and activation of metabolic processes during the early stages of seed germination (Sivritepe and Eris, 2000; Varier *et al.,* 2010).

**Seedling vigour index (SVI) and (SVII):** The seedling vigour index (SVI) of germinating seeds has a significant impact on agricultural seedling establishment and yield (Prasad and Jois, 2021). Maximum value of SVI-I was recorded for seeds stored for upto 60 DAH while minimum value was observed in seeds stored for 0 DAH (Table 3). Overall, priming with 500 µgmL$^{-1}$ $KNO_3$ for 12 and 24 h, respectively ($T_{21}$ and $T_{22}$) gave the highest mean value of SVI-I. This priming treatment was most effective in enhancing SVI-I in seeds that had been stored for 0, 15, 30, 45 and 60 DAH respectively prior to germination. Vigour index was also significantly influenced by both priming duration as well as storage duration. Seedling vigour is an essential quality criterion that must be evaluated in addition to germination and viability tests to get an insight into the performance of a seed lot in the field or under unfavourable storage conditions, which can cause considerable changes in seed viability (Tatic *et al.,* 2008).

The maximum value of seedling vigour index-II was recorded when the seeds were kept upto 60 DAH while minimum value was noted in control seeds (0 DAH) (Table 3). Priming treatments also improved the vigour in round gourd seeds effectively with maximum value when treated with $T_{21}$ ($KNO_3$ 500 µgmL$^{-1}$/12h) and $T_{22}$ ($KNO_3$ 500 µgmL$^{-1}$/24h), respectively. Similar observations on the enhancement of seedling vigour index by $KNO_3$ and $GA_3$ was reported in watermelon seeds (Barbosa *et al.,* 2016). Vigorous seeds mobilize food stores more efficiently from storage tissues to the embryo axis, resulting in faster seedling development (Marcos-Filho, 2017). Treatment of $KNO_3$ significantly increased seedling development and seedling vigour index in sunflower seeds (Kumar *et al.,* 2013).

Thus, it can be concluded that with appropriate priming treatments, it is possible to curtail the dormancy period in freshly harvested seeds of round gourd. The germination potential of the seed lot and various related germination parameters, such as the coefficient of rate of germination, seedling length, and seedling vigour index, increased with storage duration and recorded maximum value in seeds stored for 60 DAH, though the 60 per cent germination barrier is crossed in seeds stored for 45 DAH. Priming with 500 µgmL$^{-1}$ $KNO_3$ for 24 h ($T_{22}$) exceeded the mandated germination barrier of 60per cent in freshly harvested seeds and it exceeded 80 per cent germination when primed after just 15 days of storage. In freshly harvested seeds (0 DAH), it also enhanced the coefficient of rate of germination (CRG) and decreased the mean days to germination (MDG). Thus, with $KNO_3$ priming, the storage period required for natural dormancy release is not necessary and seeds may be employed for sowing immediately after harvesting.

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**Conflict of Interest**: The authors declare that they have no conflict of interest.

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