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# Effect of Seed Priming on Seed quality Attributes of Fresh and Old seed lots of Onion (*Allium cepa* L.)

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**ABSTRACT: The most serious issues in onion crop production are the lower germination percentage of onion seeds and the loss of seed vigour *i.e.*, seed quality attributes, during storage for more than a year. Onion seed lots, *viz.*, fresh (2021) and old (2020), were treated with priming agents such as PEG 6000, $KNO_3$, $ZnSO_4$, $GA_3$ and distilled water for two durations (12 and 24 hours) and non-priming was considered as control. The experiment was designed in CRD having two factors ($S_1$ and $S_2$) and replicated four times. From the results, it was revealed that among seed lots, fresh seed lot was found to be significantly superior to old seed lot. Among priming treatments, both seed lots (fresh and old) primed with $GA_3$ @ 100 ppm for 24 hours, *i.e.*, $T_8$ recorded a maximum speed of germination (38.67, 31.82), germination (93.00, 82.00 %), seedling length (15.55, 13.60 cm), seedling dry weight (24.55, 19.42 mg), seed vigour index-I (1446.15, 1115.17) and seed vigour index-II (2283.40, 1592.75). From the present investigations, it was concluded that all seed priming methods enhanced the seed quality attributes of fresh as well old seed lots, and $GA_3$ priming was found to be the best treatment among other treatment combinations.**

**Keywords:** Onion, Priming, Seed age, $GA_3$, Seed quality.

## INTRODUCTION

The Onion (*Allium cepa* L.), the “Queen of Kitchen”, belongs to the family Amaryllidaceae. Central Asia and the Mediterranean region are the primary & secondary centres of origin. It is one of the world’s most popular vegetables and has been mostly cultivated for its intrinsic properties for more than 4000 years (Hanelt, 1990). It is characterized by its distinctive flavour and pungency due to the compound ‘Allyl propyl disulphide. Onion seeds possess a short shelf life and lose viability in less than 1-2 years because of the deterioration of seeds over the course of time, which may be caused by damage to the cell membrane organization during seed ageing. This might be the result of solute leakage that occurs along with seed imbibition during the membrane reorganization process after re-hydration (Priestley and Leopold 1979; Khan *et al*., 2004).

Seed priming is one of the methodologies that can improve the quality of natural or accelerated aged and freshly harvested seeds. Seed priming is pre-sowing seed treatment. In this process, seeds are immersed in a certain type of solution or (distilled or tap) water for controlled hydration. In which seeds go through two phases of germination *i.e.*, 1) imbibition and 2) activation phase and are subsequently dried before the third phase *i.e.*, 3) radicle protrusion (Bewley, 1997; Varier *et al*., 2010). Seed priming initiates pre-germination metabolic processes, repairs membranes, leaches inhibitors, develops immature embryos and makes seeds ready for the emergence of radicles (Ibrahim, 2016). Seed priming can be done by various methods such as osmo-priming, halo-priming, hydro-priming, hormone-priming and priming with micronutrients etc. It was found that primed seeds performed better than non-primed seeds in terms of increased vigour and germination (Anwar *et al*., 2021). The objective of the study was to determine the effect of seed priming, seed age and their interaction on seed quality attributes of onion cv. Palam Lohit of fresh and one-year-old seed lot.

## MATERIAL AND METHODS

The experiment was conducted at the laboratory of the department of Seed Science and Technology, Dr. Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh in 2021. Onion cv. Palam Lohit was used as experimental material. It is a high-yielding cultivar. It has an average bulb yield of 450-500 q $ha^{-1}$. The experiment was laid out in completely randomised design (factorial) with 11 treatments *viz*. ($T_1$) PEG 6000 @ -1.0 MPa for 12 hours, ($T_2$) PEG 6000 @ -1.0 MPa for 24 hours, ($T_3$) $KNO_3$ @ 1 % for 12 hours, ($T_4$) $KNO_3$ @ 1 % for 24 hours, ($T_5$) $ZnSO_4$ @ 0.5 % for 12 hours, ($T_6$) $ZnSO_4$ @ 0.5 % for 24 hours, ($T_7$) $GA_3$ @ 100 ppm for 12 hours, ($T_8$) $GA_3$ @ 100 ppm for 24 hours, ($T_9$) Hydropriming for 12 hours, ($T_{10}$) Hydropriming for 24 hours and ($T_{11}$) Control (non-primed); four replications and two factors *viz*. A) Seed age [$S_1$: one-year-old seed (2020) and $S_2$: fresh seed (2021)] and B) seed priming treatments. The Observations recorded in the laboratory were speed of germination, germination (%), seedling length, seedling dry weight, seed vigour index-I and seed vigour index-II. The speed of germination was calculated based on the formula of Maguire (1962) by using the top-of-the-paper method. The germination test was carried out as per ISTA procedures (ISTA, 2016). The Seedling length was measured on the $12^{th}$ day and seedling dry weight was calculated from the same seedlings selected for calculating seedling length after keeping them in the oven at 80ºC for 48 hours. According to Abdul-Baki and Anderson's formula (1973), the parameters such as seed vigour index-I and seed vigour index-II were determined.

## RESULT AND DISCUSSION

The analysis of variance illustrated that there were significant differences among different seed priming treatments, seed age (fresh and old seed lot) and their interaction at 5 % level of significance for all the seed quality attributes.

**Speed of germination:** The data presented in Table 1 depicted that the effect of priming, seed age and their interaction had significant effects on the speed of germination. Among different seed priming treatments, $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded a higher mean speed of germination (35.25) for both seed lots. Among seed lots, fresh seed lot recorded a higher mean speed of germination (32.73) as compared to the old seed lot (26.66). Among interaction between seed priming and seed age, the maximum speed of germination (38.67) was recorded in fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) which was statistically at par with $S_2T_7$ *i.e*., $GA_3$ @ 100 ppm for 12 hours (38.60) and $S_2T_6$ *i.e.*, $ZnSO_4$ @ 0.5 % for 24 hours (38.42). In the old seed lot, $S_1T_8$ *i.e*., $GA_3$ @ 100 ppm for 24 hours recorded a maximum speed of germination (31.82) which was statistically at par with $S_1T_7$ (31.75) and $S_1T_6$ (31.60) while, treatment $T_{11}$ *i.e.*, control (non-primed) recorded minimum speed of germination in fresh seed lot $S_2T_{11}$ (25.60) and old seed lot $S_1T_{11}$ (20.57). Exogenous application of gibberellins through priming treatment results in metabolic or physiological changes in the seeds by stimulating the production of hydrolases (alpha or beta amylase), particularly alpha-amylase which induces faster germination in a shorter period of duration, and thus seeds primed with $GA_3$ @ 100 ppm achieved the higher speed of germination than non-primed seeds (Jassal and Singh, 2018). Similar results of faster speed of germination due to seed priming with $GA_3$ have also been reported in aspilia Africana (Okello *et al*., 2022), onion (Brar *et al*., 2019), carrot (Sowmeya *et al*., 2018), maize (Kumari *et al*., 2017), pigeon pea (Tiwari *et al.*, 2018) and bitter gourd (Kumar and Singh 2013).

**Germination (%):** The data shown in Table 1 on the effect of seed priming on germination of fresh and old seed lots of onion cv. Palam Lohit was found to be significant at 5% level of significance. Among different seed priming treatments, seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded the highest mean germination (87.50 %) as compared to all other treatments, including control (non-primed) (68.50 %). Among seed lots, fresh seed lot recorded higher mean germination (84.00 %) as compared to old seed lot (73.38 %). Among interaction between seed priming and seed age, fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded maximum germination (93.00 %), which was statistically at par with $S_2T_7$ *i.e.* $GA_3$ @ 100 ppm for 12 hours (92.75 %). In the old seed lot, maximum germination (82.00 %) was recorded in $S_1T_8$ *i.e*. $GA_3$ @ 100 ppm for 24 hours which was statistically at par with $S_1T_7$ (81.00 %) while, treatment $T_{11}$ *i.e.* control (non-primed) recorded minimum germination in both the fresh seed lot $S_2T_{11}$ (74.00 %) and old seed lot $S_1T_{11}$ (63.00 %). Enhanced germination in fresh as well as old seeds showed that both lots responded well to $GA_3$ seed priming. The minimum germination of onion seeds is 70 %. One-year-old-lot recorded 63 % germination, due to the lower germination percentage old seed lot remains unmarketable, but priming of the old seed lot increased the germination percentage to 82 %. During seed priming with $GA_3$, gibberellins get released into the cells of the aleurone layer, where they stimulate the synthesis of alpha-amylase, which ultimately results in breakdown of reserve food material in the seeds. It results in the conversion of starch (polysaccharide) into simple sugars such as glucose and maltose, which positively affects the embryo's development capacity and improves germination in $GA_3$-primed seeds (Singh *et al*., 2018). Similar results of enhanced germination due to seed priming with $GA_3$ have also been found in chia seeds (Jadhav *et al*., 2022), shallot (Pangestuti *et al*., 2021; Agung and Diara 2017), mungbean (Nandan *et al*., 2021), onion (Brar *et al*., 2019; Muruli *et al.*, 2016), carrot (Sowmeya *et al*., 2018) and maize (Kumari *et al*., 2017).

**Table 1: Effect of seed priming on speed of germination and germination (%) of fresh and old seed lot of onion cv. Palam Lohit.**

| Treatments | Speed of germination | | | Germination* | | |
|---|---|---|---|---|---|---|
| | $S_2$ | $S_1$ | Mean B | $S_2$ | $S_1$ | Mean B |
| ($T_1$) | 27.60 | 22.07 | **24.83** | 76.25 (60.81) | 64.25 (53.25) | **70.25 (57.03)** |
| ($T_2$) | 28.15 | 23.22 | **25.68** | 79.00 (62.70) | 66.25 (54.46) | **72.62 (58.58)** |
| ($T_3$) | 34.25 | 28.27 | **31.26** | 85.75 (67.82) | 77.00(61.33) | **81.37 (64.57)** |
| ($T_4$) | 32.47 | 26.55 | **29.51** | 81.75 (64.68) | 74.25 (59.49) | **78.00 (62.09)** |
| ($T_5$) | 36.82 | 29.45 | **33.13** | 90.00 (71.54) | 79.00 (62.70) | **84.50 (67.12)** |
| ($T_6$) | 38.42 | 31.60 | **35.01** | 91.00 (72.52) | 80.00 (63.41) | **85.50 (67.96)** |
| ($T_7$) | 38.60 | 31.75 | **35.17** | 92.75 (74.35) | 81.00 (64.13) | **86.87 (69.24)** |
| ($T_8$) | 38.67 | 31.82 | **35.25** | 93.00 (74.68) | 82.00 (64.87) | **87.50 (69.78)** |
| ($T_9$) | 29.27 | 23.72 | **26.50** | 79.75 (63.23) | 68.00 (55.52) | **73.87 (59.38)** |
| ($T_{10}$) | 30.15 | 24.27 | **27.21** | 80.75 (63.95) | 72.50 (58.35) | **76.62 (61.15)** |
| ($T_{11}$) | 25.60 | 20.57 | **23.08** | 74.00 (59.32) | 63.00 (52.51) | **68.50 (55.91)** |
| **Mean A** | **32.73** | **26.66** | | **84.00 (66.87)** | **73.38 (59.09)** | |
| **Factors** | **$CD_{0.05}$** | | | | | |
| Seed age | 0.08 | | | 0.36 | | |
| Priming | 0.19 | | | 0.86 | | |
| Seed age × priming | 0.28 | | | 1.21 | | |

*Figures in parentheses are angular transformed values.

**Seedling length (cm):** The data shown in Table 2 illustrated that the effect of priming, fresh and old seed lots, and their interaction had significant effects on seedling length. Among different seed priming treatments, seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded the highest mean seedling length (14.57 cm) for both seed lots. A fresh seed lot recorded a higher mean seedling length (12.79 cm) as compared to an old seed lot (11.15 cm). Among the interactions between priming and seed lots (fresh and old), maximum seedling length (15.55 cm) was recorded in a fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) which was statistically equivalent to $S_2T_7$ *i.e.*, $GA_3$ @ 100 ppm for 12 hours (15.37 cm). In the old seed lot, $S_1T_8$ *i.e.*, $GA_3$ @ 100 ppm for 24 hours recorded maximum seedling length (13.60 cm) which was statistically at par with $S_1T_7$ (13.47 cm) while, treatment $T_{11}$ *i.e.*, control (non-primed) recorded minimum seedling length in fresh seed lot $S_2T_{11}$ (9.30 cm) and old seed lot $S_1T_{11}$ (8.15 cm). Seeds soaked in $GA_3$ solution (priming) resulted in accelerated cell division and cell elongation in the apical meristem region of the plumule and radicle which ultimately increased seedling length, growth and overall seedling development (Sharma *et al.*, 2016). Similar results of increased seedling length due to seed priming with $GA_3$ have also been reported in cowpea, onion (Brar *et al.*, 2019; Singh *et al.*, 2018), shallot (Agung and Diara 2017), maize (Kumari *et al.*, 2017), bell pepper (Sharma *et al.*, 2016), cucumber (Rehman *et al.*, 2011) and wheat (Shakirova *et al.*, 2003).

**Seedling dry weight (mg):** The perusal of data presented in Table 2 indicated that the effect of priming, seed age and their interaction showed a significant effect on the seedling dry weight of onion cv. Palam Lohit. Among different seed priming treatments, seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded the highest mean seedling dry weight (21.98 mg) as compared to all other treatments including control (non-primed) (14.00 mg). Among seed lots, the fresh seed lot recorded a higher mean seedling dry weight (20.30 mg) as compared to the old seed lot (15.92 mg).

**Table 2: Effect of seed priming on seedling length and seedling dry weight of fresh and old seed lot of onion cv. Palam Lohit.**

| Treatments | Seedling length (cm) | | | Seedling dry weight (mg) | | |
|---|---|---|---|---|---|---|
| | $S_2$ | $S_1$ | Mean B | $S_2$ | $S_1$ | Mean B |
| ($T_1$) | 10.45 | 9.15 | **9.80** | 17.07 | 13.22 | **15.15** |
| ($T_2$) | 10.72 | 9.40 | **10.06** | 17.85 | 13.77 | **15.81** |
| ($T_3$) | 13.62 | 11.75 | **12.68** | 20.30 | 16.47 | **18.38** |
| ($T_4$) | 12.65 | 11.32 | **11.98** | 19.27 | 15.32 | **17.30** |
| ($T_5$) | 14.17 | 12.15 | **13.16** | 22.50 | 17.90 | **20.20** |
| ($T_6$) | 15.05 | 13.12 | **14.08** | 24.17 | 19.02 | **21.60** |
| ($T_7$) | 15.37 | 13.47 | **14.42** | 24.35 | 19.32 | **21.83** |
| ($T_8$) | 15.55 | 13.60 | **14.57** | 24.55 | 19.42 | **21.98** |
| ($T_9$) | 11.60 | 10.15 | **10.87** | 18.30 | 14.17 | **16.23** |
| ($T_{10}$) | 12.22 | 10.42 | **11.32** | 18.82 | 14.70 | **16.76** |
| ($T_{11}$) | 9.30 | 8.15 | **8.72** | 16.17 | 11.82 | **14.00** |
| **Mean A** | **12.79** | **11.15** | | **20.30** | **15.92** | |
| **Factors** | **$CD_{0.05}$** | | | | | |
| Seed age | 0.07 | | | 0.09 | | |
| Priming | 0.17 | | | 0.21 | | |
| Seed age × priming | 0.24 | | | 0.30 | | |

Among interaction, maximum seedling dry weight (24.55 mg) was recorded when fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) which was statistically at par with $S_2T_7$ *i.e.* $GA_3$ @ 100 ppm for 12 hours (24.35 mg). In the old seed lot, $S_1T_8$ *i.e.* $GA_3$ @ 100 ppm for 24 hours recorded maximum seedling dry weight (19.42 mg) which was statistically at par with $S_1T_7$ (19.32 mg) while, treatment $T_{11}$ *i.e.* control (non-primed) recorded minimum seedling dry weight in fresh seed lot $S_2T_{11}$ (16.17 mg) and old seed lot $S_1T_{11}$ (11.82 mg). The increased seedling dry weight in chia seeds was observed by Jadhav *et al.* (2022), who reported that when chia seeds were primed with $GA_3$ @ 100 ppm, recorded higher seedling dry weight because $GA_3$ enhanced the water uptake of the seedling which ultimately triggered the enzymes involved for the mobilization of food reserves in endosperm which positively worked for the vigorous seedling production. As a result, the fresh weight of seedlings increased, favourably correlated with the dry weight of seedlings. Similar findings of higher seedling dry weight due to seed priming with $GA_3$ have also been reported in salvia (Costa *et al*., 2021), onion (Brar *et al*., 2019; Singh *et al*., 2018), carrot (Sowmeya *et al*., 2018) and linseed (Rastogi *et al*., 2013).

**Seed vigour index-I:** The data recorded on the effect of seed priming on seed vigour index-I of fresh and old seed lots of onion is found to be significant and given in Table 3. Among various seed priming treatments, seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded a higher mean seed vigour index-I (1280.66) for both seed lots. Fresh seed lot recorded higher mean seed vigour index-I (1084.96) as compared to old seed lot (831.27). Among interaction, maximum seed vigour index-I (1446.15) was recorded in fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) which was statistically at par with $S_2T_7$ *i.e*., $GA_3$ @ 100 ppm for 12 hours (1422.27). In the old seed lot, $S_1T_8$ *i.e*., $GA_3$ @ 100 ppm for 24 hours recorded maximum seed vigour index-I (1115.17) which was statistically at par with $S_1T_7$ (1091.42). While, treatment $T_{11}$ *i.e.,* control (non-primed) recorded minimum seed vigour index-I in fresh seed lot $S_2T_{11}$ (688.12) and old seed lot $S_1T_{11}$ (513.40). Seed vigour index-I is the product of germination percentage and seedling length. $GA_3$ seed priming increased the soluble protein contents which resulted in synthesis and repair of membrane; activation and resynthesis of DNA, RNA and enzymes which are required for reserve mobilization etc. which enhanced germination, seedling development and ultimately seed vigour index-I (Jadhav *et al.*, 2022). Similar findings of higher seed vigour index-I due to seed priming with $GA_3$ have also been reported in sapota (Patel *et al*., 2021), onion (Brar *et al*., 2019; Muruli *et al*., 2016), soybean (Jassal and Singh, 2018) and bell pepper (Thakur *et al*., 1997).

**Seed vigour index-II:** The data about the effect of seed priming on seed vigour index-II of fresh and old seed lots of onion is presented in Table 3 and found to be significant. Among different seed priming treatments, seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) recorded a higher mean seed vigour index-II (1938.07) for both seed lots. Among seed lots, the fresh seed lot recorded a higher mean seed vigour index-II (1724.69) as compared to the old seed lot (1178.46). Among interaction, maximum seed vigour index-II (2283.40) was recorded in fresh seed lot ($S_2$) primed with $GA_3$ @ 100 ppm for 24 hours ($T_8$) which was statistically at par with $S_2T_7$ *i.e*., $GA_3$ @ 100 ppm for 12 hours (2258.47). In the old seed lot, $S_1T_8$ *i.e*., $GA_3$ @ 100 ppm for 24 hours recorded maximum seed vigour index-II (1592.75) which was statistically at par with $S_1T_7$ (1565.35). While, treatment $T_{11}$ *i.e.,* control (non-primed) recorded minimum seed vigour index-II in fresh seed lot $S_2T_{11}$ (1724.69) and old seed lot $S_1T_{11}$ (1178.46). Seed vigour index-II is the product of germination percentage and seedling dry weight. When seeds were primed with $GA_3$ (100 ppm) induced huge free space between the embryo and endosperm which played a significant role in speeding up germination by facilitating increased water uptake and improved germination, seedling length, seedling dry weight and finally seed vigour index-II (Tiwari *et al*., 2018). Similar findings of higher seed vigour index-II due to seed priming with $GA_3$ have also been reported in castor bean (Ergin *et al*., 2022), onion (Brar *et al*., 2019), mung bean (Tiwari *et al*., 2019), pigeon pea (Tiwari *et al*., 2018) and bell pepper (Sharma *et al*., 2016).

**Table 3: Effect of seed priming on seed vigour index-I and seed vigour index-II of fresh and old seed lot of onion cv. Palam Lohit.**

| Treatments | Seed vigour index-I | | | Seed vigour index-II | | |
|---|---|---|---|---|---|---|
| | **($S_2$)** | **($S_1$)** | **Mean B** | **($S_2$)** | **($S_1$)** | **Mean B** |
| ($T_1$) | 796.67 | 587.77 | **692.22** | 1302.00 | 849.80 | **1075.90** |
| ($T_2$) | 825.82 | 622.57 | **724.20** | 1410.12 | 912.75 | **1161.44** |
| ($T_3$) | 1165.05 | 904.87 | **1034.96** | 1740.37 | 1268.90 | **1504.64** |
| ($T_4$) | 1033.00 | 840.92 | **936.96** | 1575.72 | 1137.65 | **1356.69** |
| ($T_5$) | 1275.67 | 959.82 | **1117.75** | 2025.07 | 1339.15 | **1682.11** |
| ($T_6$) | 1369.47 | 1050.02 | **1209.75** | 2199.90 | 1522.00 | **1860.95** |
| ($T_7$) | 1422.27 | 1091.42 | **1256.85** | 2258.47 | 1565.35 | **1911.91** |
| ($T_8$) | 1446.15 | 1115.17 | **1280.66** | 2283.40 | 1592.75 | **1938.07** |
| ($T_9$) | 925.12 | 702.05 | **813.59** | 1459.52 | 963.85 | **1211.69** |
| ($T_{10}$) | 987.15 | 755.90 | **871.52** | 1520.05 | 1065.90 | **1292.97** |
| ($T_{11}$) | 688.12 | 513.40 | **600.76** | 1196.90 | 745.00 | **970.95** |
| **Mean A** | **1084.96** | **831.27** | | **1724.69** | **1178.46** | |
| **Factors** | **$CD_{0.05}$** | | | | | |
| Seed age | 8.56 | | | 17.00 | | |
| Priming | 20.07 | | | 39.88 | | |
| Seed age × priming | 28.39 | | | 56.40 | | |

## CONCLUSION

From the present studies, it is concluded that priming treatments, seed age and their interaction had a significant variation on all the seed quality attributes under study. All priming treatments improved seed quality of freshly harvested as well as one-year-old seed lot and seed priming with $GA_3$ @ 100 ppm for 24 hours ($T_8$) is found to be superior over all other priming treatments which is statistically at par with $T_7$ *i.e*., $GA_3$ @ 100 ppm for 12 hours. Treatment $T_{11}$ *i.e*., control (non-primed) in both the seed lots recorded minimum values.

## FUTURE SCOPE

Low germination crops can be improved by various priming methodologies including the latest methods of seed priming such as nano-priming etc.

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