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ORIGINAL RESEARCH ARTICLE

Effect of different priming applications on seed germination and seedling growth of brinjal (*Solanum melongena* L.)

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ABSTRACT

An experiment was conducted in IAAS, Lamjung to determine the effects of different priming treatments on seed germination and seedling growth of brinjal (var. Purple Long). The experiment was laid out under a single factor completely randomized design (CRD) with six treatments and five replications. The seeds of brinjal were primed with distilled water, 10% polyethylene glycol (PEG), 4% Mannitol, 2% sodium chloride (NaCl) and 100 ppm gibberellic acid (GA3) which were compared with non-primed seeds as a control. The seeds of brinjal were primed by direct immersion for 24 hours and were dried for moisture equilibrium recovery after hydration. The result showed that GA3 priming significantly ($p<0.05$) reduced mean germination time and enhanced germination percentage of brinjal, root length, and vigor index than unprimed brinjal seeds. Priming with distilled water resulted good root length and greater fresh weight of brinjal than other primed and unprimed brinjal seeds. GA3 priming was found better than other treatments as compared to control. Thus, seed priming with GA3 would be beneficial for better seed germination and subsequent growth of seedlings in brinjal.

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INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) is an important solanaceous vegetable of tropics and subtropics. It is also called aborigine in Europe. It is a very low-calorie vegetable and has healthy nutritional profile. It contains good amount of essential B- complex group of vitamins such as pantothenic acid (vitamin B5), pyridoxine (vitamin B6), thiamine (vitamin B1) and niacin (vitamin B3). It is the versatile crop adapted to different agro-climatic regions. The eggplants are very rich source of fiber and low soluble carbohydrates. Seed priming is the controlled hydration technique of seeds to a level which permits pre-germinative metabolic activities to proceed, but prevents actual emergence of the radicle. It is one of the physiological approaches that improves the seed performance and provides faster and synchronized germination (Abraha & Yohannes, 2013). It represents the partial germination of seed by soaking in either water or in a solution of salts for a specified period of time and then re-drying them just before the radicle emerges (Sour *et al.*, 2024). There are various priming techniques such as hydro priming (use of water-distilled water), halo priming (use of salt solution-NaCl), osmo-priming (use of osmotic solution-PEG, mannitol,), etc. In the present study, we are concerned with different priming agents (Oliveira *et al.*, 2019).

Seed primed with plant growth hormones like GA3 and IAA have interaction with ABA and auxin (Iqbal *et al.*, 2006). Osmo priming increases the level of amylase and protease in the germinating seed which results in vigorous growth and good crop establishment. Hydro priming reduces the inhibitory action of trypsin inhibitors and which inhibits the role of trypsin like proteolytic enzymes. Various priming techniques have been followed such that the speed and synchrony of seed germination increase (Bradford, 1986). Farooq *et al.* (2005) stated that hydropriming resulted in improved germination speed, seedling fresh and dry weight, root and shoot length, seedling nitrogen and total sugar. Bitter gourd seeds primed with 100 ppm GA3 for 24 hours gave better germination, field emergence, speed of

emergence, seedling length and vigour Index-I over the control (Kumar & Singh, 2013). Dursun & Ekinchi (2010) reported that the highest germination percentages were obtained in both hydropriming and mannitol treatments as compared with PEG and KNO_3 treatments in parsley seeds. Salt negatively affects the flow of water towards roots is negatively affected by salt, and water conductivity of plant roots is also reduced. As a result, cell membrane permeability drops and influx of water to the plant is reduced (Waisel, 1972). Hydropriming and PEG 6000(10%) priming improved the germination characteristics of Beiguan, compared to the control (Sun *et al*., 2011).

MATERIALS AND METHODS

Experimental design and procedure

This study was conducted in the laboratory of Horticulture-Institute of Agriculture and Animal Science, Lamjung campus. Seeds of brinjal (*Solanum melongena* L.) of variety Purple Long were used. The experiment was carried out in single factorial Completely Randomized Design (CRD) having 5 replications and 6 treatments. The priming agents were Distilled water, GA3 (100 ppm), Mannitol 4%, NaCl 2%, and PEG 10%. Dry seeds were taken as control. 100 ml of priming media was prepared for each priming application, and 25 seeds soaked in the solution for 24 hours at room temperature. After the priming application, seeds were washed with distilled water, dried on paper towels at room temperature, and ventilated until they regained their original moisture content. Twenty-five seeds for each treatment were placed in Petri dishes. Seeds were incubated in a germination chamber at 25±2°C for 14 days, with regular supervision.

Data collection and parameters

Seeds were considered germinated when there was a visible coleoptile protrusion of more than 3 mm in length through the seed coat. Germinated seeds were recorded daily until day 14 of the experiment.

Germination Percentage (%): Germination percentage (GP) was evaluated according to the following equation described by (Ahammad *et al*., 2014).

Germination percentage = (Number of germinated seeds *100) / (Total number of seeds used)

Mean Germination Time (MGT): Mean germination time was calculated by using the formula (Moradi *et al*., 2008).

Mean germination time = $\sum Dn/\sum n$

Where, Dn is the number of days counted from beginning of germination; n is the number of different seed lots.

Root and shoot length: On the final day of germination test, 10 samples from each petri dish were taken in random and root length and shoot length of the sample seedlings were measured manually with a ruler.

Germination Index (GI): Germination index emphasizes on both the percentage of germination and its speed. In germination index, maximum weight is given to the seeds germinated at the first day and less to those germinated on the last day. A higher GI value denotes higher percentage and rate of germination. The methodology of calculating germination index followed (Bench-Arnold *et al*., 1991).

Germination index = (14*N1) + (15*N2) +.....+ (1*N14)

Where, N1, N2.....N14 is the number of germinated seeds on the first, second, and subsequent days until 14th day
The multipliers (e.g. 14, 13,.....1) are the weights given to the days of the germination.

Seedling vigor Index-I: Seedling vigor index -I was calculated by using the modified formula of (Abdul-Baki & Anderson, 1973).

Seedling vigor Index-I = Average seedling length (cm) *Germination percentage

Fresh weight of seedling: After the measurement of root and shoot length, the fresh weight excluding excess moisture was measured by weighing machine in gram at the end of experiment.

Statistical analysis

Statistical analysis was performed using R Studio computer software version 1.2.5033.0 (RStudio, 2019) in concert with the R core package version 3.6.2 (R Core team, 2019). The Agricolae package in R (De Mendiburu, 2012) was used to perform mean separation. Mean separations were based on Tukey's test ($P < 0.05$).

RESULTS AND DISCUSSION

Germination percentage and germination index

Germination count is an important physiological parameter which is generally used to assess the planting value of seeds. The percent seed germination, germination time and germination index of brinjal are given in Table 1. Statistically significant results were observed in case of seed germination percentage when subjected to different priming treatments. Priming with GA3 recorded maximum germination count. Our results are in agreement with those of Behera (2016), who studied the effect of priming agents on seed germination parameters of solanaceous vegetables. Our results are further confirmed by those of Tian *et al*. (2014). Seed priming of carrot, onion and tomato with gibberellic acid leads to increase of germination and seed vigor (Sedghi *et al*., 2008). GA3 stimulates the synthesis, activation and secretion of hydrolytic enzymes, mainly α-amylase releasing reducing sugars and aminoacids which are essential for embryo growth (Khan, 1971). GA3 treated seed was closely associated with their rapid utilization in the synthesis of various amino acids and amides (Gupta & Mukherjee, 1982), which could be the

Table 1. Effect of various treatments on germination parameters of brinjal.

Priming media	Germination %	Mean germination time	Germination index
Control	44.80[b]	11.93[a]	0.70 [b]
Distilled water	49.60[b]	9.09[b]	0.86 [b]
PEG (10%)	50.40[b]	8.86[b]	0.91 [b]
Mannitol (4%)	44.80[b]	9.15[b]	0.82 [b]
NaCl (2%)	43.20[b]	9.35[b]	0.73 [b]
GA3 (100 ppm)	67.20[a]	5.92[c]	1.62 [a]
LSD	9.26***	1.20***	0.33***
CV %	14.19	10.16	27.23
Grand mean	50.00	9.05	0.94

reason for the increased germination rate. In this experiment, lower seed germination percentage was obtained with NaCl priming. The most researchers believe that the decrease of germination rate is the result of decreasing water potential and seed accessibility to water (Mohammadi, 2009). In case of germination index, statistically similar results were found among different treatments except GA3. The mean performance of germination index ranged from 1.62 to 0.70 with the mean value of 0.94. GA3 primed seeds showed the highest germination index (1.62). All the priming treatments showed higher germination index than the control (0.70). Higher germination index represents higher percentage and rate of germination.

Mean germination time: The effect of priming was found statistically significant for mean germination time (Table 1). The lowest time was taken by GA3 treated seeds. The highest time was required by the control while other treatments were similar for mean germination time. Our result was confirmed by Khan *et al.* (2011) and Sedghi *et al.* (2008) who reported that the germination time of pepper and tomato seed primed in GA solution for different periods reduced the average germination time by 2-3 days. The reduction in MGT by priming can be explained by the fact that priming activates and synthesize hydrolytic enzymes e.g., lipases, amylases and proteases which mobilize storage materials in seed and on rehydration quick emergence take place because all pregerminative processes had already taken place (Varier *et al.*, 2010). GA3 facilitates germination by weakening the mechanical restraint of the endosperm cells to permit radicle protrusion. Gibberellin strengthens and enhances the growth of embryo (Ogawa *et al.*, 2003).

Root and shoot length: Priming treatments had significant effect on enhancing root and shoot length of brinjal (Figures 1 and 2). Priming with distilled water produced the highest root length. The effect of hydro priming is significantly different from the control. Sanchez *et al.* (2001) also found that the root length of cucumber and pepper increased due to hydro-priming effects. Similarly, this result agrees with the findings of Eisvand *et al.* (2011) who reported the hydro-priming and hormonal priming by gibberellin and salicylic acid on seed and seedling quality of carrot. The positive effect of hydropriming may be due to the maintenance of tissue water content, increase in antioxidant activities and carbohydrate metabolism (Farooq *et al.*, 2005). The increase in root length may be due to its involvement in cell elongation or cell division and the meristematic growth (Khan *et al.*, 2006). Shoot length was not significantly affected by seed priming. GA3 priming produced the highest shoot length. The results are in line with the work of (Toklu, 2015) which showed that lentil seeds primed with GA3 showed the increased shoot length than the other treatments in the laboratory condition. GA3 stimulates hydrolytic enzymes that are needed for the degradation of the cells surrounding the radicle and thus speeds germination by promoting seedling elongation growth of seeds (Rood *et al.*, 1990). Batool *et al.* (2015) reported that shoot cells growth depends upon water availability and when cell was exposed to water shortage as result shoot growth decrease.

Seedling Vigor Index-I (SV-I): Priming treatments showed significant effect in SV-I (Figure 3). It is evident that seeds primed with GA3 exhibited maximum SV-I. The result agrees with the findings of Shineeanwarialmas *et al.* (2019) and Kumar & Singh (2013). Ga3 primed seed showed increased germination and vigor (Kumari *et al.*, 2017). This vigor enhancement by using growth regulator as priming agent might be due to increased cell division within the apical meristem of seedling root, which caused an increase in plant growth (Khan *et al.*, 2011). Moreover, hormonal treatments maintain the IAA and cytokinin levels in the plant tissues, which enhance the cell division. The increase of vigor index might be related to reduction of imbibition lag time for priming treatment (Bradford, 1986). Having lower germination percentage and seedling length has resulted in lower vigor Index-I value in control.

Fresh weight: Fresh weight of seedlings was significantly influenced by priming media (Figure 4). The highest fresh weight was recorded in seeds primed with distilled water (0.47 g), which was significantly greater than all other treatments which is contrary to the finding of (Sour *et al.*, 2024) where priming with distilled water continued to yield the lowest fresh weight. Control and PEG-primed seeds (0.43 g each) formed a statistically similar group, whereas GA3 (0.38 g) and mannitol (0.40 g) priming resulted in lower fresh weights. The lowest value was observed under NaCl priming (0.02 g), which was drastically reduced compared to all other treatments. Under the 400 mM NaCl treatment, the plants from the NPr seeds exhibited the lowest shoot biomass compared to all the other priming groups (Tolra *et al.*, 2025), which support our result. The results obtained are in contrast with (Koirala *et al.*, 2018) where non-significant result was observed on 20 days old seedling.

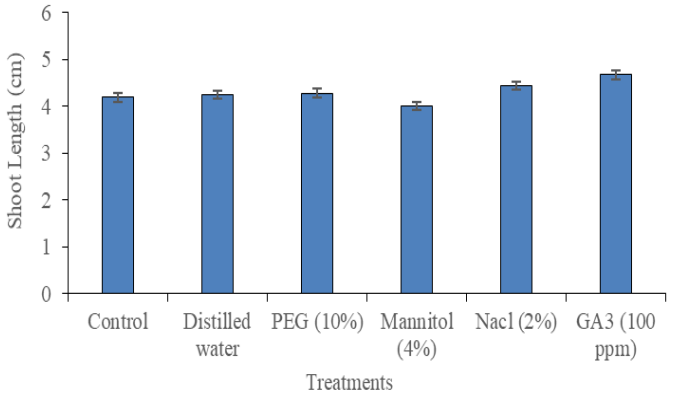

Figure 1. *Effect of various treatments on shoot length of brinjal.*

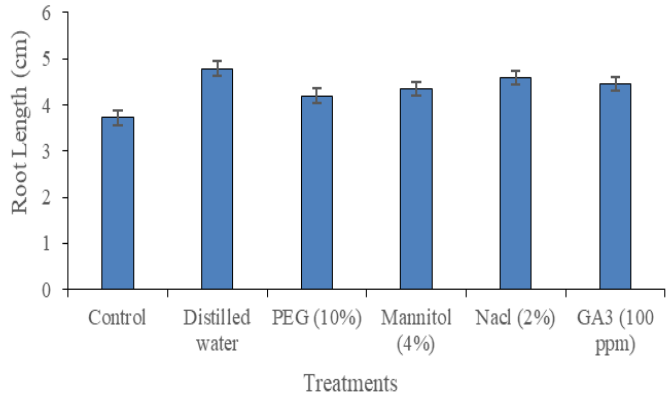

Figure 2. *Effect of various treatments on root length of brinjal.*

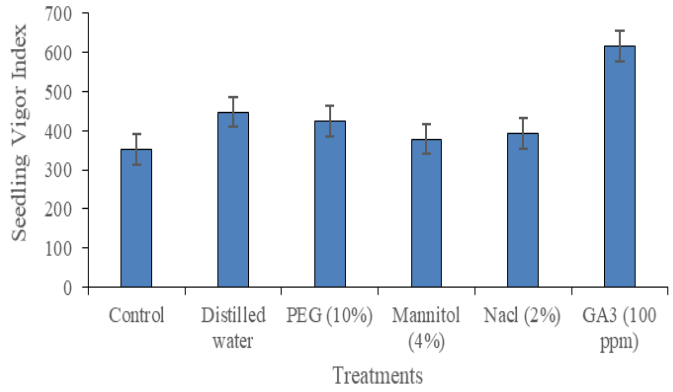

Figure 3. *Effect of various treatments on seedling vigor index of brinjal.*

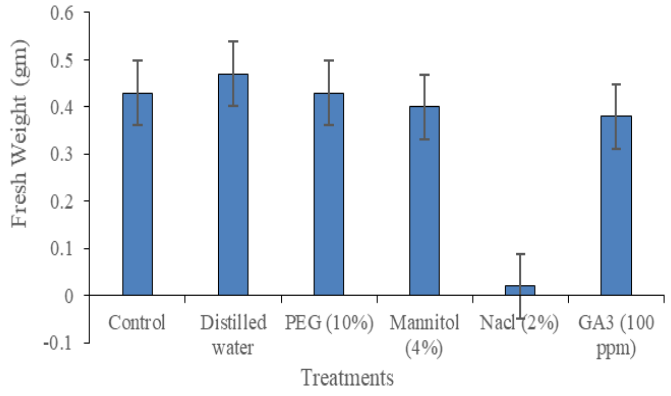

Figure 4. *Effect of various treatments on fresh weight of brinjal.*

Conclusion

The study indicated that among the different priming agents used in the study, priming with GA3 (100ppm) increased the seed germination, germination index and seed vigor parameters. Priming with distilled water can be used as a cheap and convenient way to improve crop establishment which even showed best seedling weight as compared to non-primed and other primed seeds. Hormonal priming with GA3 was found to be most effective for improving overall germination and early growth of seedlings. Thus, it would be more beneficial to prime brinjal seeds with GA3 to alleviate the problem of poor seed germination and seedling establishment. this experiment Further studies should be required to verify the findings of this study in different seasons and locations using more replications.

DECLARATIONS

Author contribution statement: Samikshya Parajuli conceived and designed the study, conducted the experiments, collected and analyzed the data, and drafted the manuscript. Niraj Bhattarai contributed to data interpretation, provided critical revisions, and assisted in finalizing the manuscript. Both authors read and approved the final version of the paper.

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