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ENHANCEMENT OF SEED GERMINATION AND EARLY SEEDLING GROWTH THROUGH SEED PRIMING AGENTS IN BRINJAL

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Abstract

Two experiments were conducted in the laboratory of Plant Physiology Section of Horticulture Research Centre, Bangladesh Agricultural Institute (BARI) for two consecutive years of 2021 and 2022 for 14 days during 13 February to 26 February to investigate the effect of different priming agents on seed germination, germination parameters, seedling growth and vigour of brinjal (*Solanum melongena* L.). During 2021, the experiment consisted of two brinjal varieties *viz*, BARI Begun-6 and BARI Begun-10 and seven priming agents *viz*., Hydropriming (DH_2O), Gibberellic acid (GA_3) @ 289 µM, Potassium chloride (KCl) @ 134 mM, Urea @ 167 mM, Sodium chloride (NaCl) @ 40 mM, and Diammonium phosphate (DAP) @ 70 mM PEG_{6000} @ 5%) with unprimed control, whereas during 2022 the experiment comprised the same two varieties of brinjal and seven priming agents *viz*., Hydropriming (DH_2O), Gibberellic Acid (GA_3) @ 289 µM, Potassium Nitrate (KNO_3) @ 0.25%, Hydrogen peroxide (H_2O_2) @ 40 mM, Sodium Chloride (NaCl) @ 40 mM, α -triacontanol (TRIA) @ 1 µM and Naphthalene Acetic Acid (NAA) @ 50 ppm. The experiments of both years were laid out in completely randomized design with three replications. In the 1st year, seed germination, germination index, germination rate index, coefficient of velocity of germination, seedling growth (shoot length, root length and seedling dry weight) and seedling vigour (seedling vigour index I and-II) were enhanced significantly in both the varieties with 289 µM of GA_3. In the 2nd year, seeds of the two brinjal varieties treated with 40 mM H_2O_2 showed the maximum germination percentage, germination index, germination value, seedling growth (shoot length, root length and seedling dry weight) and seedling vigour (seedling vigour index I and -II) compared to the other treatments. From the two years' results, it was concluded that either 40 mM H_2O_2 or 0.25% KNO_3 or 289 µM GA_3 can be used as priming agent to enhance the seed germination, growth and seedling vigour of brinjal seed. Prior to sowing or going for breeding work, it was suggested that brinjal seeds should be primed with H_2O_2 or KNO_3 or GA_3 concentrations for 18 hrs to obtain maximum germination and vigourous seedlings.

Keywords: Brinjal, *Solanum melongena*, germination, seedling vigour, germination value, priming, H_2O_2, KNO_3.

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Introduction

Brinjal or eggplant (*Solanum melongena* L) is an important vegetable crop of the family solanaceae. It is one of the most commonly grown vegetable crops which is cultivated both in winter and summer seasons across the country. Brinjal fruit (unripe) is primarily consumed as cooked vegetable in various ways and dried shoots are used as fuel in rural areas. It is low in calories and fats, contains mostly water, some proteins, fiber and carbohydrates. It is a good source of minerals and vitamins and is rich in total water-soluble sugars, free reducing sugars, amide proteins among other nutrients.

Seed germination in field condition is a key factor for crop growth and yield. Low germination percentage, delayed germination and retarded in seedling growth are common problem in brinjal. The germination percentage of brinjal is around 70% under the environment of Bangladesh and India (Agarwal, 1995; Das *et al*., 2020), which is very low compared to that of developed countries. Good seedling establishment under some stress conditions may ensure good crop growth as well as better yield (Nayak and Patra, 2000). It has been reported that due to the lack of quality seedlings, yield of crops decreased by about 15% in Bangladesh (FAO, 2000). Rapid germination and emergence are essential for successful crop establishment, for which seed priming could play an important role. Seed priming is a controlled hydration technique that activates the normal metabolic processes during the early phase of germination (Hussain *et al*., 2016; Silva and Silva, 2016).

Good germination and stand establishment are the maximizing factors in crop production, and their importance is well recognized by farmers and researchers. It has been reported that Gibberellic acid (GA_3), Sodium Chloride (NaCl), Muriate of Potash (KCl), Urea, Diammonium Phosphate (DAP) and Polyethylene glycol (PEG) are used as seed priming materials (Tian *et al*., 2014, Anosheh *et al.*, 2011; Koirala *et al.,* 2019). It is also reported that seeds priming with potassium nitrate (KNO_3), Hydrogen peroxide (H_2O_2), Triacontanol and Naphthalene Acetic Acid (NAA) can improve germination percentage in tomato (Ali *et al*., 2020; Saidi *et al*., 2024). Seed priming, by increasing speed and uniformity of germination, could help to obtain elite seedling along with better crop stand (Ghiyasi *et al.,* 2008; Islam *et al*., 2012). In Bangladesh, farmers are badly in need of appropriate technology for optimizing germination and crop growth of vegetable crops. However, the information on suitable priming technology for potential germination is scanty, especially on the popular vegetables in Bangladesh like brinjal. The investigation was, therefore, conducted to determine appropriate priming agent to increase germination percentage and quality attributes of brinjal seedling.

Materials and Methods

The experiment was conducted at the laboratory of Plant Physiology Section, Horticulture Research Centre, BARI during 2021 and 2022 for 14 days during 13

February to 26 February. The experiment consisted of two factors- Factor A: two varieties, namely ‘BARI Begun-6’ and ‘BARI Begun-10’ and Factor B: 8 seed priming treatments *viz*., in 2021, P_1 = control (no priming), P_2 = hydro-priming by distilled water (DH_2O), P_3 = 289.0 µM gibberellic acid (GA_3), P_4 = 134 mM muriate of potash (KCl), P_5 =167.0 mM Urea, P_6 = 40 mM sodium chloride (NaCl), P_7 = 76 mM diammonium phosphate (DAP) and P_8 = 5% polyethylene glycol (PEG_{6000}). During 2022, some treatments were changed, such as: T_1 = Control (No priming), T_2 = Hydropriming by DH_2O, T_3 = 289 µM GA_3, T_4 = 0.25% KNO_3, T_5 = 30 µM H_2O_2, T_6 = 40 mM NACL, T_7 = 1 µM TRIA, T_8= 5 ppm NAA. During 2021, no seeds were germinated when seeds were primed with KCL, Urea and DAP. Therefore, KCL, Urea and DAP were replaced by KNO_3, H_2O_2 and Triacontanol. PEG was also replaced by NAA. BARI Bagun-6 fruit is oval shaped and light green in colour, and this variety has been recommended for cultivation in winter season. Its seed germination is poor and erratic. ‘BARI Begun-10’ fruit is elongated and bright violet in colour, and this variety has been recommended for cultivation year-round. Its seeds germination is also poor and uneven. Due to two different types of brinjal variety in nature, these two varieties were selected for this experiment. The seeds of these varieties were collected from Olericulture Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI). Required number of petri dishes each with a diameter of 9 cm were used in the experiment and arranged in a completely randomized design (CRD) moistened with respective treatment in three replications. Three layers of commercial tissue paper were used in each petri dish for retaining required amount of water for imbibition of seeds. Before setting the experiments, seeds were primed with respective solutions for 18 hours. Twenty healthy and equal sized seeds of BARI Bagun-6 and BARI Begun-10 were selected and placed on sterilized petri dish lined with tissue paper.

The seeds were sterilized by soaking in 0.1% mercuric chloride for 5 min and then seeds were washed with distilled water well to remove the mercuric chloride adhered to the seed surface. The priming of seed was done in the dark at 26 ± 2℃ for 24 hours. The seeds of control treatment were not primed. The solution was changed after 12 hours to facilitate aeration in seeds. The ratio of seed weight to solution volume (w/v) was 1:5. After 18 hours, the primed seeds were washed with water for 3-4 times and dried in shade at 27 ± 2℃ until the moisture content was decreased to initial moisture content. The sterilized and primed seeds were placed on the petri dish lined with filter paper.

The perti dishes with seeds of the selected varieties of brinjal were kept in normal room temperature (27 ± 2℃) for germination. Solution of chemicals used in each year was prepared by dissolving calculated amount of lab grade chemicals with distilled water. The respective prime solutions were poured into the petri dish @ 5 ml/petri-dish, separately. In control treatment, 5 ml distilled water was added to the petri dishes. The germination count was taken after 72 hours of placing seeds. The 5 ml of distilled water (control) and 5 ml solution of salinity were added separately in the petri dishes. No nutrient solution was added to the petri dishes. The petri dishes were covered to prevent the loss of moisture by evaporation. Number of seeds germinated was counted daily and data recording were continued up to 14 days. At 14 days, 10 seedlings (shoot + root) were weighed by the electrical balance and this weight was considered as fresh weight of seedling, and these seedlings were kept in an oven at 72^{O}c for 1 week for recording dry weight of seedling. At 14 days, the shoot and the root length of ten randomly selected seedlings from each replicate were measured.

Germination and Germination indices

The number of seeds germinated was recorded daily up to 14 days. Seeds were considered germinated upon emergence of radicles (≥ 2 mm) (Sharma and Sharma, 2010). From these germination counts, several germination attributes were calculated, including final germination percentage (%), germination index, coefficient of velocity of germination (CVG) (Kader and Jutzi, 2004) and germination rate index (GRI) (Kader, 2005), germination value (GV) and mean germination time (MGT) as follows:

Germination Percentage (GP)

Final Germination percentage (FGP) was calculated using the following formulas (Li, 2008 and Mostafavi *et al*., 2011):

Germination percentage (GP) = $\frac{\mathrm{a}}{b} \times 100$

where, a = total number of seeds germinated

b = total number of seeds to germinate

Coefficient of Velocity of Germination and Germination Index

CVG (% day^{-1}) $=\sum Ni/\sum(NiTi) \times 100$,

GRI (%day^{-1}) $=\sum Ni/I$,

where N is the number of seeds germinated on day i, and T_i is the number of days from sowing. The CVG gives an indication of the rapidity of germination: it increases when the number of germinated seeds increases and the time required for germination decreases. The GRI reflects the percentage of germination on each day of the germination period. Higher GRI values indicate higher and faster germination.

Germination Index (GI) = (12 x N1) + (11 x N2) + ...+ (2x N11) + (1 x N12): where N1, N2 .....N13, N14 is the the number of germinated seeds on the first, second and subsequent days until 14th and multipliers (eg., 12, 13..... etc) are weight given to the days of the germination (Kader, 2005).

Mean Germination Time

MGT = $\Sigma Dn/\Sigma n$, Where, n is the number of seeds which were germinated on day D, and D is the number of days counted from the beginning of germination. GRI = [(G1/1) + (G2/2) + (Gx/X)], Where, G is the germination on each alternate day after placement 1, 2 and x is the corresponding day of germination (Ranal *et al.,* 2009).

Germination Value

GV= (DDGs /N) x GP /10 (Djavanshir and Pourbeik, 1976), where DG is daily germination speed obtained by dividing the cumulative germination percentage by the number of days since sowing. DDGs is total germination obtained by adding DGs value obtained from the daily counts. N is the total number of daily counts, starting from the date of first germination.GP is Germination percentage at the end of the test and 10 as a constant.

Seedling Vigour Index

The seedling vigour index I and II were calculated as per the method prescribed by Abdul-Baki and Anderson (1973) and expressed in whole number. Seedling Vigour index I = Germination (%) × mean seedling length (cm) and Seedling Vigour index II = Germination (%) × dry weight/ seedling (mg) and they were expressed in number.

All data were analyzed through MSTATC software and means were separated with the help of Tukey HSD test at 5% level of probability.

Results and Discussion

Germination percentage

During 2021, brinjal var. BARI Begun-6 showed maximum germination percentage when primed with 289.0 µM GA_3 (66.67% in 2021) followed by 40 mM NaCl (48.90%) and the lowest from control (no priming) (Table 1). During 2021, BARI Begun-10, priming with GA_3 at 289.0 µM gave maximum germination (53.33%) followed by 5% PEG (51.78%) and 40 mM NaCl (47.90%) and the lowest value was recorded from control (22.67%) (Table 1). In both the varieties, during 2021 hydropriming gave higher germination (40% in BARI Begun-10 and 46.67% in BARI Begun-10 than unprimed control (Table 1).

During 2022, both varieties, maximum germination percent was obtained from 40 mM H_2O_2 primed seeds (97.24% in BARI Begun-6 and 100% in BARI Begun-10) followed by 0.25% KNO_3 (86.66% in BARI Begun-6 and 90.85% in BARI Begun-10). The lowest value was observed in unprimed seeds of BARI Begun-6 (42.60%), though in BARI Begun-10, the lowest germination was found from 50 ppm NAA primed seeds of BARI Begun-10 (29.15%) (Table 2). In both the varieties, during 2021 hydropriming gave higher germination (56.05% in BARI Begun-6 and 67.26% in BARI begun-10) than unprimed control (Table 2). Saidi *et al.* (2024) reported that tomato seeds primed with 50 and 100 mM H_2O_2 improved germination in saline solutions. Ali *et al.* (2020) obtained significantly higher germination percentage with 0.25% KNO_3 (87%) than that of control (83%). Parajuli and Bhattaraj (2025) obtained the highest germination (67%) from 100 ppm GA_3 primed brinjal seeds.

Table 1. Effect of different priming treatments on germination percentage, germination index, germination rate index and coefficient of velocity of germination of two brinjal varieties during 2021

Treat	Germination percentage		Germination index		Germination Rate Index		Coefficient of velocity of germination	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
P_1	35.0d	22.67cd	35.5d	23.5d	3.32e	2.83e	11.29d	11.20e
P_2	40.00c	46.67c	36.5c	45.0c	4.03d	6.27c	11.61c	12.00d
P_3	66.67a	53.33a	51.0a	51.1ab	7.09a	7.10a	14.82a	14.89a
P_4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P_5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P_6	48.90b	47.90bc	44.0b	55.0a	6.62b	6.71b	12.5b	12.3c
P_7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
P_8	40.00c	51.78ab	31.5d	47.0bc	4.40c	5.98	11.09d	12.9b
CV (%)	6.01	6.01	5.02	5.02	5.36	5.36	6.45	6.45

Figures in a column, having same letter (s) do not differ significantly at 5% level by Tukey's W test. P_1 = control (no priming), P_2 = hydro-priming by distilled water, P_3 = 289.0 μM GA_3, P_4 = 134.0 mM KCl, P_5 =167.0 mM Urea, P_6 = 40.0 mM NaCl, P_7 = 76.0 mM DAP, P_8 = 5% PEG_{6000}; V_1 = BARI Begun-6 and V_2 = BARI Begun-10

Table 2. Effect of different priming treatments on germination percentage, germination index, germination value and mean germination time of two brinjal varieties during 2022

Treat	Germination percentage		Germination index		Germination value		Mean germination time (days)	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1	42.60g	44.84e	501.81f	524.72e	74.88f	98.72e	8a	11a
T_2	56.05d	67.26d	679.39c	852.05c	110.37c	220.92c	7cd	6e
T_3	65.02c	71.76c	529.17e	576.25d	87.43d	199.17d	8ab	9c
T_4	86.66b	90.85b	920.05b	1109.6b	185.57b	308.08b	8ab	6de
T_5	97.24a	100.00a	1031.4a	1293.8a	266.85a	467.17a	7d	6e
T_6	51.56e	35.87f	560.67d	275.79g	79.83e	28.20h	8bc	6e
T_7	43.61fg	44.85e	443.96g	845.40c	61.24h	77.44f	8b	11a
T_8	44.88f	29.15g	349.79h	358.76f	69.45g	33.90g	7bc	7d
CV (%)	4.31	4.31	3.28	3.28	3.28	3.28	2.57	2.57

Figures in a column, having same letter (s) do not differ significantly at 5% level by Tukey's W test. T_1 = Control, T_2 = Hydropriming, T_3 = 289 µM GA_3, T_4 = 0.25% KNO_3, T_5 = 40 µM H_2O_2, T_6 = 40 mM NACL, T_7 = 1 µM TRIA, T_8= 50 ppm NAA; V_1 = BARI Begun-6 and V_2 = BARI Begun-6

Germination Index, Germination rate index, Coefficient of velocity of germination and Germination value

Germination index (GI), Germination rate index (GRI), Coefficient of velocity of germination (CVG %) and Germination value (GV) indicates the speed of germination. Higher the GI, GRI, CVG and GV faster the germination of seeds. During 2021 var. BARI Begun-6, hormonal priming with 289.0 µM GA_3 (100 ppm) gave maximum values of GI (51.0), GRI (7.09) and CVG (14.82%) which were followed by 40 mM NaCl (GI-44.0, GRI-6.62, CVG-12.5%) and their lowest from control treatment (Table 1). In 2021, var. BARI Begun-10 showed the maximum GI by 40 mM NaCl (55.0) closely followed by 289.0 µM GA_3 (51.1); GRI and CVG were found maximum from 289.0 µM GA_3 (GRI-7.10 and CVG-14.89%) followed by 40 mM NaCl (GI-6.71, CVG-12.5%)

In 2022, in BARI Begun-6, priming with 40 mM H_2O_2 gave maximum values of GI (1031.4) and GV (266.85) which was followed by 0.25% KNO_3 (GI-920.05, GV-266.85) and their lowest values obtained from no priming treatment (Table 2), but in case of coefficient of velocity of germination followed by 5% PEG (12.9) and 40 mM NACL (12.3) (Table 2). During 2022, in BARI Begun-6, seeds primed with 40 mM H_2O_2 recorded the maximum GI value (1031.8) which was followed by 0.25% KNO_3 (920.05), hydropriming (679.39) and 289 µM GA_3 (529.17), and the lowest value of GI from unprimed seeds (501.81); in the same variety of brinjal, GV was also recorded maximum from 40 mM H_2O_2 (266.85) followed by 025%

KNO_3 (185.87) and the lowest GV in 1 µM TRIA (69.45), but in case of coefficient of velocity of germination followed by 5% PEG (12.9) and 40 mM NACL (12.3) (Table 2). In BARI Begun-6, seeds primed with 40 mM H_2O_2 recorded the maximum GI value (1031.8) which was followed by 0.25% KNO_3 (920.05), hydropriming (679.39) and 289 µM GA_3 (529.17), and the lowest value of GI from unprimed seeds (501.81); in the same variety of brinjal, GV was also recorded maximum from 40 mM H_2O_2 (266.85) followed by 025% KNO_3 (185.87) and the lowest GV in 1 µM TRIA (69.45).

The control treatment and 1 µM TRIA took higher germination time (11 and 11 days) in case of BARI Begun-10 but 40 mM H_2O_2 took the lowest germination time (6 days) identical with 40 mM NaCl (6 days) and hydropriming (6 days) for BARI Begun-10 during 2022 (Table 2). In the same year and same variety, the lowest germination time was observed from control (6 days) which was followed by hydropriming 40 mM H_2O_2 and 0.25% KNO_3. During 2022, in BARI Begun-6, unprimed control took maximum time (8 days) closely followed by 289.0 µM GA_3 (8 days) and 0.25% KNO_3 (8 days) and 40 mM H_2O_2 primed seeds took the lowest time (7 days). Ahmed *et al.* (2017) reported that seeds treated with 1 dS/m NaCl gave the maximum germination index in tomato, brinjal and chilli.

Shoot length and root length

In 2021, the results showed that priming agents except urea, KCl and DAP had stimulatory effect on shoot length of brinjal along the growth period (Table 3). During 2021, var. BARI Begun-10 showed the maximum shoot length (5.6 cm) from 289.0 µM GA_3 identical with hydro-priming (49 cm) and no priming (53 cm) and the lowest length in 5% PEG (3.5 cm). In 2021, var. BARI Begun-10 gave maximum shoot length from 289.0 µM GA_3 (4.5 cm) which was statistically similar with 40 mM NaCl (4.4 cm) and hydropriming (4.3 cm) and its minimum value in 5% PEG. BARI Begun-6 enhanced root length significantly higher with GA_3 at 289.0 µM over other treatments (Table 3). At 14 DAS, the maximum root length was 5.0 cm at 289.0 µM GA_3 followed by hydropriming (4.5 cm) whereas the lowest length of roots was observed in control (Table 3). In BARI Begun-10, the priming treatment of 40 mM NaCl gave maximum root length (3.3 cm) which was followed by 289.0 µM GA_3 (2.5 cm). Priming with PEG gave negative effect on root length of both varieties. The unprimed and hydro-primed seeds also gave lower seed length (2.1 cm and 2.2 cm).

In 2022, var. BARI Begun-6 showed the highest shoot length from 40 mM H_2O_2 (5.25 cm) which was identical with 289.0 µM GA_3 (5.24 cm), 0.25% KNO_3 (5.17 cm); whereas priming with 50 ppm NAA gave the lowest shoot length (0.93 cm). In BARI Begun-10 of 2022, maximum shoot length was recorded from 0.25% KNO_3 (4.73 cm) which was statistically similar with no priming (4.64 cm), hydropriming (4.51 cm), 289 µM GA_3 (4.44 cm) and 40 mM H_2O_2 (4.21 cm) and priming with 50 ppm NAA gave the lowest shoot length (0.85 cm) (Table 4). In BARI Begun-6 hydropriming enhanced root length closely followed 40 mM H_2O_2 (Table 4). At 14 DAS, the maximum root length was 1.71 cm at hydropriming treatment statistically similar with 40 mM H_2O_2 (1.65 cm) followed by 1. 35 cm produced by 289.0 µM GA_3. The lowest length of roots was obtained from 1 µM TRIA (0.58 cm) and 50 ppm NAA (0.62 cm). (Table 4). In BARI Begun-10, 2022, the priming treatment of 40 mM NaCl gave maximum root length (1.91 cm) which was closely followed by 40 mM H_2O_2 (1.75 cm) and the lowest length of roots in 50 ppm NAA (0.53 cm) and 1 µM TRIA (0.60 cm). Islam *et al.* (2006) obtained maximum shoot length (5.3 cm) and root length (5.35 cm) from 100 ppm GA_3 primed brinjal seeds after 15 DAS (days after sowing) in petri dish. Ahmed *et al.* (2017) reported that seeds treated with 1 dS/m NaCl gave the maximum shoot and root length in tomato, brinjal and chilli. Parajuli and Bhattarai (2025) obtained the highest shoot length and root length from 100 ppm GA_3 primed brinjal seeds.

Seedling Vigour Index I

In 2021, in var. BARI Begun-6, hormonal priming with 289.0 µM GA_3 recorded maximum Seedling Vigour Index I (706.7) which was closely followed by halo-priming with 40 mM NaCl (420.5), and hydropriming (392.0) whereas priming of seed with 5% PEG gave the lowest result (240.0) (Table 3). In 2021, var. BARI Begun-10 showed similar result. Hormonal priming with 289.0 µM GA_3 recorded maximum Seedling Vigour Index I (373.3) which was closely followed by halo-priming with 40 mM NaCl (368.8) and hydro-priming (303.4) and 5% PEG (243.4), and no priming gave the lowest result (138.3).

Table 3. Effect of different priming treatments for 18 hrs on shoot length, root length and seedling vigour index I of two brinjal varieties during 2021

Treat	Shoot length (cm)		Root length (cm)		Seedling vigour Index I	
	V_1	V_2	V_1	V_2	V_1	V_2
P_1	4.9a	4.0b	4.0cd	2.1c	311.5c	138.3d
P_2	5.3a	4.3ab	4.5b	2.2c	392.0c	303.4b
P_3	5.6a	4.5a	5.0a	2.5b	706.7a	373.3a
P_4	0.0	0.0	0.0	0.0	0.0	0.0
P_5	0.0	0.0	0.0	0.0	0.0	0.0
P_6	4.5c	4.4a	4.1c	3.3a	420.5b	368.8a
P_7	0.0	0.0	0.0	0.0	0.0	0.0
P_8	3.5d	2.5c	2.5d	2.0c	240.0 d	243.4c
CV (%)	2.10	2.10	2.35	2.35	3.56	3.56

Figures in a column, having same letter (s) do not differ significantly at 5% level by Tukey's W test. P_1 = control (no priming), P_2 = hydro-priming by distilled water, P_3 = 289.0 µM GA_3, P_4 = 134.0 mM KCl, P_5 =167.0 mM Urea, P_6 = 40.0 mM NaCl, P_7 = 76.0 mM DAP, P_8 = 5% PEG-6000, V_1 = BARI Begun-6 and V_2 = BARI Begun-10.

During 2022, in BARI Begun-6, maximum seedling vigour index I was observed in 40 mM H_2O_2 (670.96) which was followed by 0.25% KNO_3 (526.95) and 289.0 µM GA_3 (428.33) and minimum was obtained when seeds were primed with 50 ppm NAA (69.29). In 2022, in BARI Begun-10, maximum seedling vigour index I was recorded from 40 mM H_2O_2 (596.20) which was followed by 0.25% KNO_3 (504.16), hydropriming (424.44) and its minimal value was found in 50 ppm NAA (40.28). Hemalatha *et al.* (2017) obtained maximum seed vigour from the seeds primed with 0.25% H_2O_2 in rice. Ahmed *et al.* (2017) reported that seeds treated with 1 dS/m NaCl gave the maximum vigour in tomato, brinjal and chilli.

Table 4. Effect of different priming treatments for 18 hrs on shoot length, root length, and seedling vigour index I of two brinjal varieties during 2022

Treat	Shoot length (cm)		Root length (cm)		Seedling Vigour Index I	
	V_1	V_2	V_1	V_2	V_1	V_2
T_1	4.10 c	4.64a	1.35b	0.84c	300.52d	287.13c
T_2	4.67b	4.51a	1.71a	1.80ab	357.48d	424.44b
T_3	5.24a	4.44a	1.35b	1.66b	428.33c	273.95d
T_4	5.17ab	4.73a	0.91c	0.81cd	526.95b	504.16b
T_5	5.25 a	4.21a	1.65ab	1.75a	670.96a	596.0a
T_6	2.93 d	3.37b	0.80cd	1.91a	192.03f	189.21e
T_7	2.46d	2.25c	0.58d	0.60de	132.64g	204.85e
T_8	0.93e	0.85d	0.62d	0.53e	69.29h	40.28f
CV (%)	5.32	5.98	8.94	6.17	4.10	4.27

Figures in a column, having same letter (s) do not differ significantly at 5% level by Tukey's W test. T_1 = Control (No priming), T_2 = Hydropriming, T_3 = 289 µM GA_3, T_4 = 0.25% KNO_3, T_5 = 40 mM H_2O_2, T_6 = 40 mM NACL, T_7 = 1 µM TRIA, T_8= 50 ppm NAA; V_1 = BARI Begun-6 and V_2 = BARI Begun-10.

Seedling dry weight

In 2021, in var. BAR Begun-6, the highest seedling dry weight was recorded from 289.0 µM GA_3 (3.48 mg) which was identical with hydropriming (3.20 mg) and the lowest seedling dry weight in control (Fig. 1). The same trend of seedling dry weight was also found in BARI Begun-10. Priming with 289.0 µM GA_3 gave maximum seedling dry weight (2.11 mg) which was statistically similar to priming with 40 mM NACL (1.99 mg), hydropriming (1.98 mg), priming with 5% PEG (1.98 mg) and the lowest seedling dry weight from unprimed treatment.

In 2022, in BARI Begun-10, hormonal priming also produced the highest seedling dry weight (Fig. 2). In BARI Begun-6, the treatment 0.25% KNO_3 gave the maximum seedling dry weight (4.19 mg) which was identical with 40 mM H_2O_2 (4.00 mg) and the minimal seedling dry weight was found in 1 µM TRIA (Fig. 2). On the other hand, in BARI Begun-10, maximum seedling dry weight was obtained from 0.25% KNO_3 (3.05) which was statistically similar with 40 mM H_2O_2 (2.99 mg), hydropriming (2.91 mg) and the lowest seedling dry weight was noticed in 1 µM TRIA (2.15 mg) closely followed by control (2.55 mg). Ali *et al*. (2020) obtained significantly maximum seedling dry weight (14.7 mg) when seeds were primed with KNO_3 compared to control (11.9 mg) in tomato. Hemalatha *et al.* (2017) obtained maximum seedling dry weight from the seeds primed with 0.25% H_2O_2 in rice.

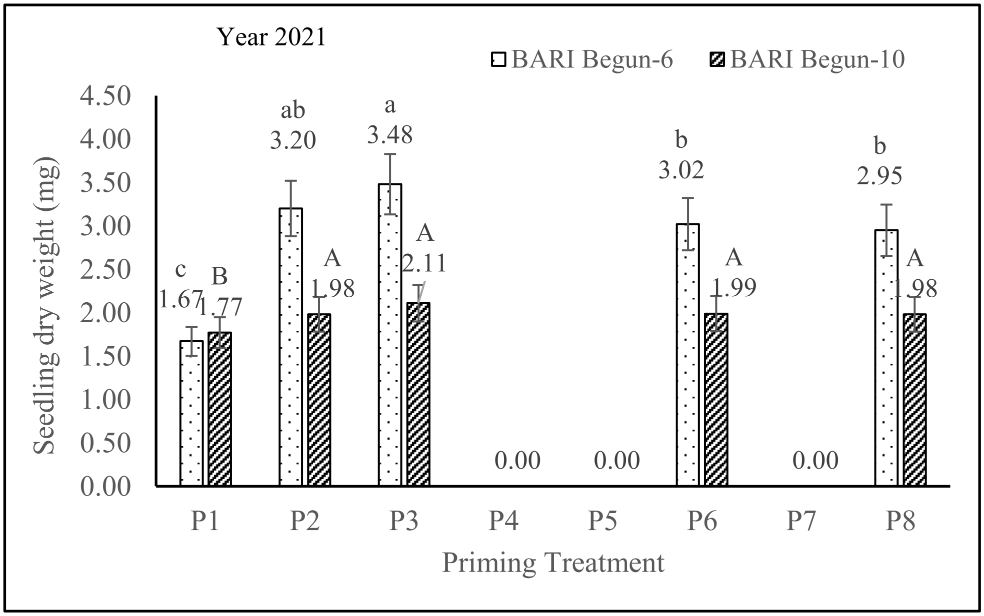

Fig. 1. Effect of seed priming on seedling dry weight in two varieties of brinjal during 2021.

Figures with the same small letter (s) and capital letter (s) for BARI Begun-6 and BARI Begun-10, respectively, are not significantly different ($P \leq 0.05$) by Tukey HSD test. Bars indicate mean SE ± of three replicates. P_1 = control (no priming), P_2 = hydro-priming by distilled water, P_3 = 289.0 µM GA_3, P_4 = 134.0 mM KCl, P_5 =167.0 mM Urea, P_6 = 40.0 mM NaCl, P_7 = 76.0 mM DAP, P_8 = 5% PEG-6000; V_1 = BARI Begun-6 and V_2 = BARI Begun-10.

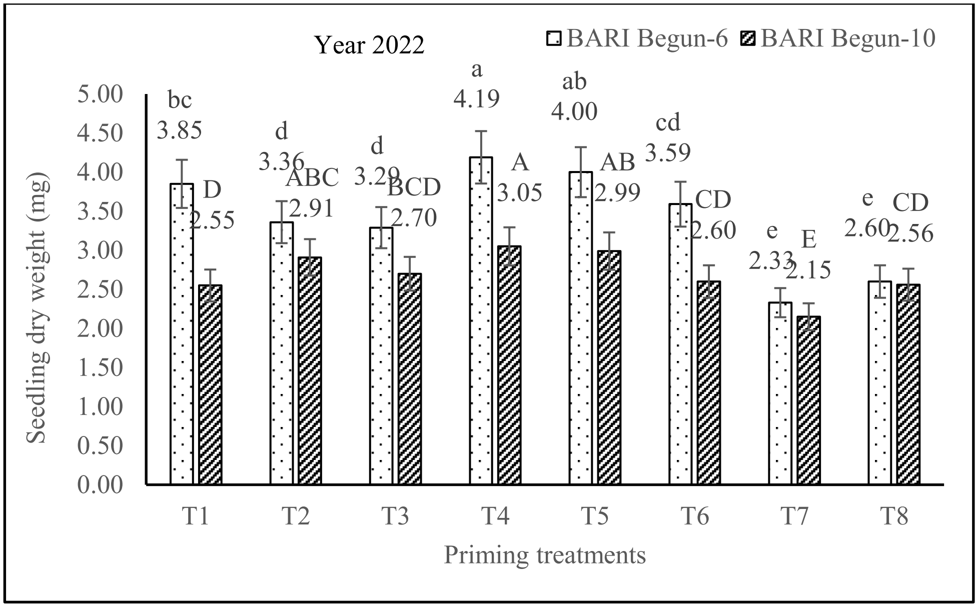

Fig. 2. Effect of seed priming on seedling dry weight in two varieties of brinjal during 2022.

Figures with the same small letter (s) and capital letter (s) for BARI Begun-6 and BARI Begun-10, respectively, are not significantly different ($P \leq 0.05$) by Tukey HSD test. Bars indicate mean ± SE of three replicates. T_1 = Control (No priming), T_2 = Hydropriming, T_3 = 289 µM GA_3, T_4 = 0.25% KNO_3, T_5 = 40 mM H_2O_2, T_6 = 40 mM NACL, T_7 = 1 µM TRIA, T_8= 50 ppm NAA; V_1 = BARI Begun-6 and V_2 = BARI Begun-10.

Seedling Vigor Index II

Seedling Vigour Index II in BARI Begun-10 was found lower than that in BARI Begun-6 (Fig. 3). During 2021, var. BARI Begun-6 showed the maximum Seedling Vigour Index II from the seeds primed with 289 µM GA_3 (232.01) followed by 40 mM (4 dS/m) NaCl (146.70), 5% PEG and its minimum value was recorded from the unprimed seeds (Fig. 3). In BARI Begun-10 the maximum seedling vigour index was also recorded from 289 µM GA_3 (112.53) followed by 5% PEG (102.52), 40 mM (4 dS/m) NACl (95.32), hydropriming (92.41) and the lowest value was observed from the unprimed seeds (40.13).

During 2022, in BARI Begun-6, seeds primed with 40 mM H_2O_2 gave the maximum Seedling Vigour Index (388.96) which was statistically similar with 0.25% KNO_3 (363.11) (Fig. 4). There was no significant difference found among 289 µM GA_3 (213.92), hydropriming (188.33) and 40 mM NACl priming (185.10) in respect of Seedling Vigour Index II. The lowest seedling vigour index was noticed from 5% PEG treatment. In contrast, in BARI Begun-10, the maximum seedling vigour index II was observed from 40 mM H_2O_2 (299.00) closely followed by 0.25% KNO_3 (277.09) and hydro-priming (187.50). During 2022, in var. BARI Begun-10 with 289 µM GA_3 did not perform well compared to hydro-priming with regard to seedling vigour index II and the lowest seedling vigour index was recorded from 5% PEG treatment.

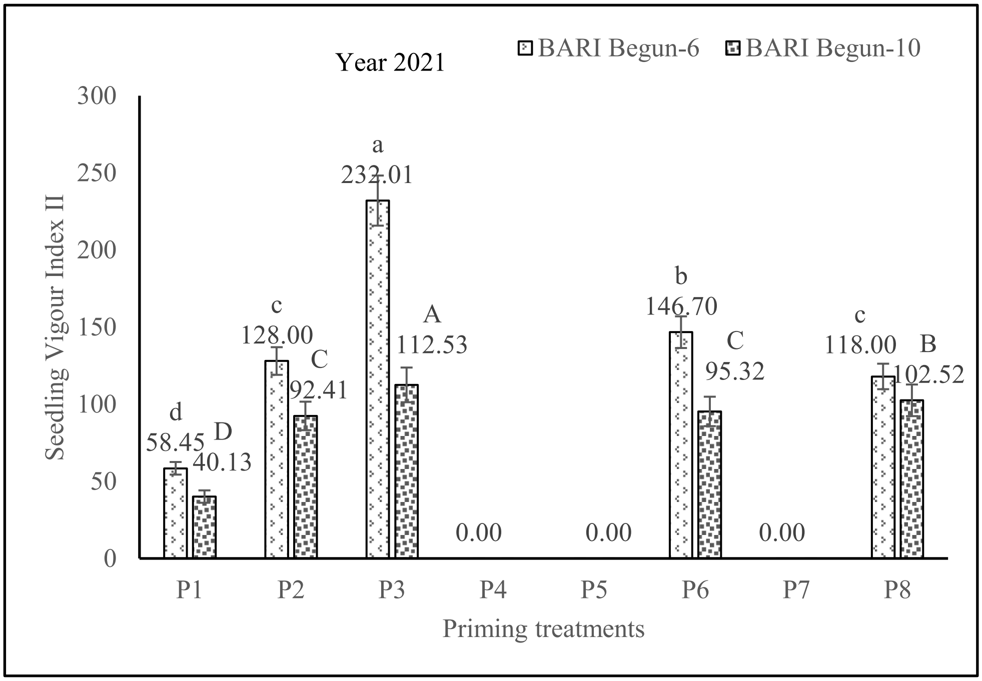

Fig. 3. Effect of seed priming on seedling vigour index II in two varieties of brinjal during 2021.

Figures with the same small letter (s) and capital letter (s) for BARI Begun-6 and BARI Begun-10, respectively, are not significantly different ($P \leq 0.05$) by Tukey HSD test. Bars indicate mean SE ± of three replicates. P_1 = control (no priming), P_2 = hydro-priming by distilled water, P_3 = 289.0 µM GA_3, P_4 = 134.0 mM KCl, P_5 =167.0 mM Urea, P_6 = 40.0 mM NaCl, P_7 = 76.0 mM DAP, P_8 = 5% PEG-6000; V_1 = BARI Begun-6 and V_2 = BARI Begun-10.

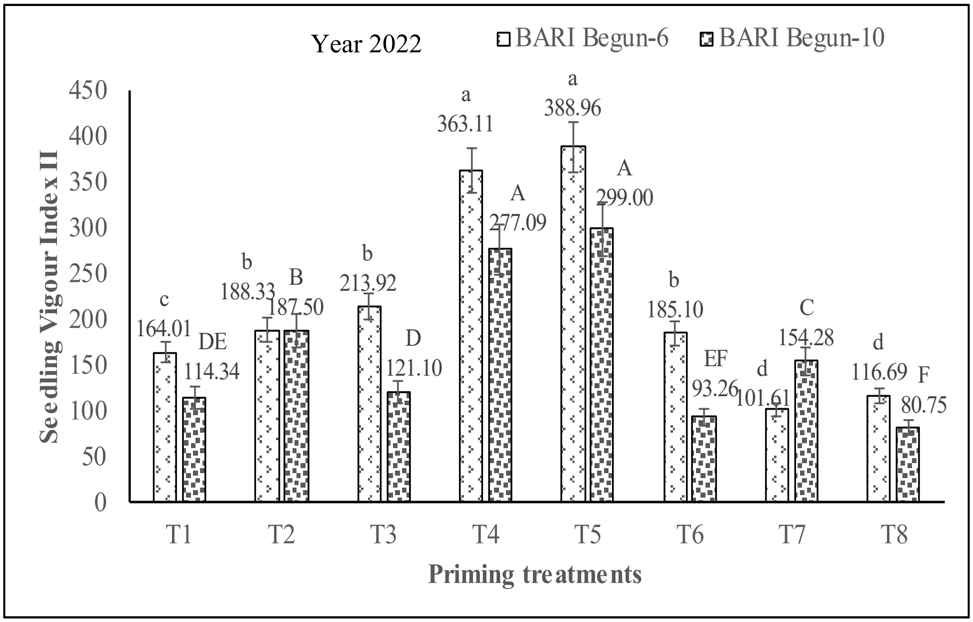

Fig. 4. Effect of seed priming on seedling seedling vigour Index II in two varieties of brinjal during 2022.

Figures with the same small letter (s) and capital letter (s) for BARI Begun-6 and BARI Begun-10, respectively, are not significantly different ($P \leq 0.05$) by Tukey HSD test. Bars indicate mean ± SE of three replicates. T_1 = Control (No priming), T_2 = Hydropriming, T_3 = 289 µM GA_3, T_4 = 0.25% KNO_3, T_5 = 40 mM H_2O_2, T_6 = 40 mM NACL, T_7 = 1 µM TRIA, T_8= 50 ppm NAA; V_1 = BARI Begun-6 and V_2 = BARI Begun-10

Conclusion

From the present study it was found that in 2021 289 µM (100 ppm) GA_3 was the most important priming agent to increase seed germination, germination index, shoot length, root length and seedling vigour of brinjal varieties. However, in the 2nd year, GA_3 did not give encouraging result with regard to germination, germination parameters, seedling growth and vigour. The 2nd year experimental results showed that 40 mM H_2O_2 followed by 0.25% KNO_3 enhanced percent germination, germination index, germination value, shoot length, root length, seedling dry weight and seedling vigour of two brinjal varieties. Seeds primed with 40 mM H_2O_2 took the lowest time to germinate. Therefore, it is suggested that brinjal seeds should be primed with 40 mM H_2O_2 or 0.25% KNO_3 or 289 µM GA_3 for 18 hrs. Priming with either 40 mM H_2O_2 or 0.25% KNO_3 or 289 µM (100 ppm)

GA_3 before sowing or breeding work is very effective for obtaining maximum seed germination and healthy seedlings that can produce higher yield of brinjal.

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