

## **Original Research Article**

### **Invigorating Effect of Seed Priming as Pre-Treatment Factors on Germination and Seedling Vigour of Tomato**

#### **ABSTRACT**

A study was undertaken to enhance germination and seedling vigour of tomato cultivar BCT-25 were subjected to different priming treatments with an objective to enhance germination and seedling vigour. [The seed](#)Seed was primed with different priming materials like Moringa leaf extract for eighteen hours; 1% NaCl for thirty-six hours; 10% Polyethylene glycol (PEG) for twelve hours; 100 ppm GA<sub>3</sub>, 5% KNO<sub>3</sub> (under dark condition) and 1000 ppm Thiourea for twenty-four hours; distilled water for twelve hours; 2% KH<sub>2</sub>PO<sub>4</sub> and 93 ppm NAA (at 4°C) for six hours. All the treatments resulted in improved germination and seedling vigour compared with untreated seeds; however, highest vigour was observed in subject to hydro priming, followed by KH<sub>2</sub>PO<sub>4</sub> in both the years; minimum vigour index was noted for T<sub>0</sub>. Highest mean germination percentage was found for hydro priming followed by T<sub>8</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> during both the years, while [the lowest average germination percentage](#)lowest average germination percentage was recorded for T<sub>0</sub> in two consecutive years. In the field, highest magnitude of seedling emergence was recorded in hydro priming, i.e., 89.67% in first and 86.67% in [the second year](#)second year, followed by T<sub>8</sub>, T<sub>1</sub>, T<sub>2</sub> while it was lowest for T<sub>0</sub> under laboratory condition. Hydro priming observed in [the highest field vigour index](#)highest field vigour index as compared to all other treatments. All the cases, hydro-priming and KH<sub>2</sub>PO<sub>4</sub> observed [better](#)best performance than other priming materials. But, some cases hydro-priming and KH<sub>2</sub>PO<sub>4</sub> were non-significant variation in both laboratory and field condition. From this experiment, it can be concluded that at [the initial stage](#)initial growth, [plantial stage of](#) growth plant hydro-priming and KH<sub>2</sub>PO<sub>4</sub> play the best performance than other priming materials.

**KEY WORDS:** Priming; tomato; seedling vigour; germination.

#### **1. INTRODUCTION**

Tomato is a perennial plant, normally grown as an annual plant, in the Solanaceae, with a weakly woody stem that usually scrambles over other plants. The fruit is an edible, brightly coloured (usually red, from the pigment lycopene) berry. This cultivable species has a diploid genome with 12 chromosome pairs, i.e., 2n (24). A 100 g of raw tomato supplies 18 kcal energy, 3.9 g of carbohydrates, 0.2 g of fat and 0.9 g of protein, and a moderate amount of vitamin C. Freshly harvested tomato seeds often fail to germinate due to presence of dormancy. Dormancy has also been reported even in one year old seeds. The minimum germination percentage was maintained [up to](#)up to 8th month of storage in refrigerated condition (1). Seed priming is one of the most important physiological methods which improves the seed performance and provides faster and synchronized germination (2). The primed seeds give earlier, more uniform and sometime greater germination and seedling establishment and growth (3). Now-a-days, several priming techniques have been evolved which are being utilized in different crops. Among them, hydro-priming, halo-priming and osmo-priming are [the](#) most common and popular techniques (4). Application of Gibberellic

Acid (GA<sub>3</sub>) has been reported to increase [the](#) germination percentage and seedling growth of crop plants under salt stress (5). The influence of GA<sub>3</sub> has been found to enhance seedling growth of crop plants (6; 7). Classical seed priming methods, as well as seed bio-priming techniques, have beneficial effects on tomatoes, in terms of ameliorating seed germination, seedling emergence and vigour, as well as confirming the optimal evolution of all physiological processes throughout the seasons, both in greenhouse and field conditions, under normal and/or stress situations (8). The effect of seed treatments with growth regulators on yield and yield components of common bean (*Phaseolus vulgaris* L.) lines was shown (9). Highest number of grains pod<sup>-1</sup> and biological yield (14602 kg ha<sup>-1</sup>) due to [the](#) growth regulator application was obtained from line D81083 in 0.5 m mol L<sup>-1</sup> NAA. Effect of different concentrations of PEG on the germination, seedling growth and water relation behaviour of four wheat genotypes under laboratory condition was studied (10). All the parameters showed the best results when wheat seeds treated with 10% PEG solution compared to nonprime and hydro primed seeds, and the value decreased gradually with increasing PEG concentration. The genotype, ESWYT-5 performed best. The effect of different priming agents involving GA<sub>3</sub> (1 ppm), KNO<sub>3</sub> (5%), Na<sub>2</sub>HPO<sub>4</sub> (2%), PEG (10%), ZnSO<sub>4</sub> (1%), Ascorbic acid (50 ppm), and deionized H<sub>2</sub>O was shown (11). Seeds of different solanaceous vegetable crops were soaked for 24 hours and again dried back to their original moisture content under [the](#) shade dry condition. Observations were recorded on germination/field emergence, root length, shoot length, seedling length, seedling dry weight, seedling vigour index-I & II in both lab and field tests. KNO<sub>3</sub> was found as the best priming treatment followed by Na<sub>2</sub>HPO<sub>4</sub> and GA<sub>3</sub> in improving different seed quality parameters. Bio-priming treatment is potentially able to promote quick and even germination as well as better plant growth (12). Priming techniques ~~has~~ [have](#) been reported to help in dormancy break down in many vegetable crops including tomato (13; 14). The present investigation was carried out to observe any change occurring due to priming and assess the influence of different priming treatments over untreated control under laboratory condition with that in nursery bed under poly-house condition through its germination potential, seedling growth and vigour status.

## 2. MATERIALS AND METHODS

The laboratory experiment was carried out in [the](#) seed testing laboratory, Department of Seed science and Technology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India, during 2019-2020 and 2020-2021 following Complete Randomized Design with three replications. The field trial was conducted in Randomized Block Design with three replications at 'C' Block, Incheck Farm, Kalyani (-22.9747° N, 88.4337° E), Nadia during Rabi Oct, 2019-Feb, 2020 and Oct, 2020-Feb, 2021. The seed material for the present investigation is comprised of one tomato genotype viz., BCT-25. Seeds were obtained from AICRP Vegetables, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal.

### 2.1. Seed priming

Pre-sowing seed priming was made with different priming materials after standardisation was made for its concentrations and soaking durations as well. Seed priming was done with Moringa leaf extract (T<sub>1</sub>) (1ml of fresh leaf extract diluted with 30 ml of distilled water) for 18 hours; 1% NaCl (T<sub>2</sub>) for 36 hours; 10% Polyethylene glycol (PEG)

(T<sub>3</sub>) for 12 hours; 100 ppm GA<sub>3</sub> (T<sub>4</sub>), 5% KNO<sub>3</sub> (T<sub>5</sub>) (under dark condition) and 1000 ppm Thiourea (T<sub>6</sub>) for 24 hours; distilled water (T<sub>7</sub>) for 12 hours; 2% KH<sub>2</sub>PO<sub>4</sub> (T<sub>8</sub>) and 93 ppm NAA (T<sub>9</sub>) (at 4°C) for 6 hours. Dry seeds were considered as the control (T<sub>0</sub>). Primed seeds of each treatment were subjected to testing for its quality through glass plate method in Complete Randomized Design with three replications under laboratory condition and different seed quality parameters were recorded accordingly:

## 2.2 Germination potential

### 2.2.1 Time to 50% germination

Number of seeds germinated was recorded daily according to the AOSA method (15). The time to obtain 50% germination (T<sub>50</sub>) was calculated according to the following formulae of (16) modified by (17):

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

Where, N stands for the final number of germination and n<sub>i</sub>, n<sub>j</sub> are cumulative number of seeds germinated by adjacent counts at times t<sub>i</sub> and t<sub>j</sub> when n<sub>i</sub> < N/2 < n<sub>j</sub>.

### 2.2.2 Mean germination time (MGT)

Mean germination time (MGT) was calculated according to the equation of (18):

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

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

### 2.2.3 Germination percentage

Germination percentage (G) is calculated as:

$$G = \frac{X}{Y} \times 100$$

Where, X is the number of normal seedlings produced and Y denotes total number of seeds taken for germination (19). It is expressed in percentage.

### 2.2.4 Germination index (GI)

Germination index (GI) was calculated as described in the Association of Official Seed Analysts (20) as the following formulae:

$$GI = \frac{\text{Number of germinated seeds}}{\text{Day of first count}} + \frac{\text{Number of germinated seeds}}{\text{Day of last count}}$$

### 2.2.5 Germination Energy

Energy of germination (GE) was recorded 4<sup>th</sup> day after planting. It is the percentage of germinating seeds 4 days after planting relative to the total number of seeds tested (21).

### 2.2.6 Seedling parameters

Root lengths and shoot lengths of ten seedlings were measured at 14 days after germination by a glass plate method in the laboratory with the help of a scale and graph paper and average was made out, expressed in centimetre (cm). Fresh weight of ten seedlings was measured with the help of a digital balance. Then seedlings were dried at 60-70 °C for two hours in hot air oven and weighed in a digital balance. Both seedling fresh weight and dry weight is/are expressed in gram (g).

### 2.2.7 Vigour index

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Vigour index (VI) was calculated by using the formula suggested by Abdul Baki and Anderson (22):  $VI = G \times L$

Where, G indicates [the](#) germination percentage and L denotes seedling length (cm).

### 2.2.8 Field vigour

A part of primed seeds of each treatment ~~was-were~~ broadcasted in [a](#) nursery bed under poly-house conditioning Randomized Block Design with three replications to assess their field performance through various parameters such as field emergence (%), length of seedling (cm) and vigour index as mentioned earlier.

## 3. RESULTS AND DISCUSSION

### 3.2 Germination potential:

#### 3.2.1 Time to 50% germination

Significant variation was noticed among the priming treatments for all the physiological parameters studied under laboratory condition excepting dry weight of seedlings in second year. Minimum duration to 50% germination was recorded in T<sub>7</sub>, i.e., 6.50 days ~~at~~ first and 6.41 days in [the](#) second year, preceded by T<sub>8</sub>, T<sub>1</sub>, T<sub>2</sub> in both the years, though in second year T<sub>1</sub> and T<sub>2</sub> performed similarly in second year; maximum time to reach 50% germination was observed for T<sub>0</sub>, i.e., 10.49 days and 10.14 days in [the](#) first and second year respectively (Table 1.). Hydro-priming resulted in lower time taken to 50% germination and higher vigour index in maize (23).

#### 3.2.2 Mean germination time (MGT)

During both the years, T<sub>8</sub> (7.45 days in 2019-2020 and 7.37 days in 2020-2021) took [the](#) shortest period for mean germination and it was closely preceded by T<sub>7</sub>, though in first year T<sub>8</sub> and T<sub>7</sub> performed similarly. Similar results ~~was-were~~ noted by (24), provided lowest values for mean germination time in sunflower after priming with KH<sub>2</sub>PO<sub>4</sub>. *Vicia faba* and *Vicia sativa* cultivars observed that seed priming with KH<sub>2</sub>PO<sub>4</sub> could improve the negative effect of ageing by decreasing mean germination time and increasing [the](#) germination index than other priming including control (25).

#### 3.2.3 Germination percentage

~~The highest germination percentage~~ Highest germination percentage was found for T<sub>7</sub> (94.38 in 2019-2020 and 91.84 in 2020-2021) followed by T<sub>8</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> during both the years, while lowest average germination percentage was recorded for T<sub>0</sub> (75.13 and 74.27) in two consecutive years. This result is in agreement with (26), who observed higher germination and improved seedling growth of lentil in hydro-primed seeds.

#### 3.2.4 Germination index (GI)

~~The highest germination index~~ Highest germination index was determined for T<sub>8</sub>, i.e., 25.66 in first and 25.57 in [the](#) second year, followed by T<sub>7</sub>, T<sub>1</sub>, T<sub>2</sub>, while it was lowest for T<sub>0</sub> in both years. Priming with KH<sub>2</sub>PO<sub>4</sub> advanced germination index in sunflower (24).

#### 3.2.5 Germination energy (%)

~~The maximum energy~~ Maximum energy of germination was recorded in T<sub>8</sub> (37.88% and 37.56%) in two respective years, followed by T<sub>7</sub>, T<sub>1</sub>, T<sub>2</sub>, while it was minimum for T<sub>0</sub> in

both years. Seed priming treatments enhanced the energy of germination over that of untreated seeds and maximum energy of germination was recorded with hydro-priming in rice (27). Low vigour seeds of hybrid sunflower showed significant decrease in mean germination time and increase in germination index as well as germination energy over non-primed low vigour seeds after priming with  $\text{KH}_2\text{PO}_4$  (28). In most of the parameters,  $T_7$  and  $T_8$  showed **better** performance than other priming materials.

**Table 1. Influence of seed priming on the germination potential of Tomato**

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2019-2020					
Treatments	Time to 50% germination (days)	Mean germination time (days)	Germination (%)	Germination Index	Germination energy (%)
$T_0$	10.49	10.76	60.06 (75.13)	14.34	15.13
$T_1$	7.62	8.04	71.01 (89.44)	22.81	34.83
$T_2$	8.17	8.92	69.89 (88.21)	22.41	33.34
$T_3$	8.62	9.16	67.30 (85.14)	20.19	27.52
$T_4$	9.79	9.95	62.36 (78.51)	19.18	24.21
$T_5$	9.50	9.87	63.54 (80.19)	19.37	24.54
$T_6$	8.82	9.23	65.41 (82.72)	20.06	27.37
$T_7$	6.50	7.50	76.25 (94.38)	25.52	37.37
$T_8$	6.85	7.45	72.69 (91.18)	25.66	37.88
$T_9$	8.88	9.15	64.24 (81.15)	19.67	24.75
<b>SEm(±)</b>	<b>0.725</b>	<b>0.229</b>	<b>0.073</b>	<b>0.029</b>	<b>0.024</b>
<b>LSD (0.05)</b>	<b>0.244</b>	<b>0.077</b>	<b>0.218</b>	<b>0.085</b>	<b>0.070</b>
2020-2021					
Treatments	Time to 50% germination (days)	Mean germination time (days)	Germination (%)	Germination Index	Germination energy (%)
$T_0$	10.14	10.52	59.50 (74.27)	14.12	15.07
$T_1$	7.47	8.22	69.83 (88.14)	22.66	34.16
$T_2$	7.49	8.67	67.57 (85.47)	22.34	32.61
$T_3$	8.31	9.23	66.04 (83.55)	20.16	27.25
$T_4$	9.47	10.03	62.58 (78.82)	19.12	23.95
$T_5$	9.47	9.76	63.27 (79.81)	19.33	24.19
$T_6$	8.53	9.10	64.92 (82.07)	19.94	26.84
$T_7$	6.41	7.56	73.37 (91.84)	25.45	37.15
$T_8$	6.74	7.37	71.17 (89.61)	25.57	37.56
$T_9$	8.56	9.19	63.66 (80.35)	19.53	24.49
<b>SEm(±)</b>	<b>0.400</b>	<b>0.541</b>	<b>0.108</b>	<b>0.021</b>	<b>0.021</b>
<b>LSD (0.05)</b>	<b>0.135</b>	<b>0.182</b>	<b>0.320</b>	<b>0.063</b>	<b>0.061</b>

Note:  $T_0$  = Control,  $T_1$  = Moringa leaf extract,  $T_2$  = 1% NaCl,  $T_3$  = 10% Polyethylene glycol (PEG),  $T_4$  = 100 ppm  $\text{GA}_3$ ,  $T_5$  = 5%  $\text{KNO}_3$ ,  $T_6$  = 1000 ppm Thiourea,  $T_7$  = Distilled water,  $T_8$  = 2%  $\text{KH}_2\text{PO}_4$ ,  $T_9$  = 93 ppm NAA

### 3.2.6 Seedling parameters and vigour index

Maximum seedling root length was observed for  $T_7$ , i.e., 11.94 cm and 11.90 cm in first and second year respectively, it was followed by  $T_1$  in first and  $T_8$  in second year, though  $T_1$ ,  $T_2$  and  $T_8$  showed non-significant difference among themselves in both the years; while it

was ~~minimized~~ ~~minimum~~ for T<sub>0</sub> (6.39 cm in 2019-2020 and 6.38 cm in 2020-2021) (Table 2.). The longest seedling shoot length also was recorded for T<sub>7</sub> (3.37 cm in first and 3.34 cm in second year) followed by T<sub>3</sub>, though T<sub>3</sub>, T<sub>8</sub> and T<sub>9</sub> performed similarly in both years. In case of fresh and dry weight of seedlings also, significant variation ~~was noted~~ ~~were noted~~ in both years. Highest seedling fresh weight was observed for T<sub>7</sub>, i.e., 0.193 g and 0.190 g in the first and second year respectively, whereas, both T<sub>7</sub> and T<sub>8</sub> showed highest seedling dry weight with same magnitude of 0.017 in both years. Seed hydro-priming resulted in highest root and shoot fresh weight of seedlings in Bitter gourd (29) and sunflower seeds hydro primed for twelve hours exhibited the highest seedling dry weight (30).

### 3.2.7 Vigour index

Considering vigour index, maximum value was calculated for T<sub>7</sub>, i.e., 1445.54 and 1399.59 in first and second year respectively, followed by T<sub>8</sub> in both the years; minimum vigour index was noted for T<sub>0</sub>, i.e., 674.95 in 2019-2020 and 665.21 in 2020-2021. In most of the parameters, T<sub>7</sub> and T<sub>8</sub> showed best performance than other priming materials. But, in some cases T<sub>7</sub> and T<sub>8</sub> were non-significant variation ~~in~~ laboratory condition.

**Table 2. Influence of seed priming on seedling parameters and vigour index of Tomato:**

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2019-2020					
Treatments	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)	Vigour index
T <sub>0</sub>	6.39	2.59	0.092	0.010	674.95
T <sub>1</sub>	11.35	2.91	0.149	0.016	1275.41
T <sub>2</sub>	11.33	2.81	0.148	0.016	1247.00
T <sub>3</sub>	10.71	3.13	0.142	0.015	1178.34
T <sub>4</sub>	8.79	2.65	0.112	0.012	897.59
T <sub>5</sub>	9.58	2.67	0.116	0.012	982.29
T <sub>6</sub>	9.94	2.69	0.127	0.014	1044.71
T <sub>7</sub>	11.94	3.37	0.193	0.017	1445.54
T <sub>8</sub>	11.33	3.05	0.168	0.017	1311.42
T <sub>9</sub>	9.50	3.03	0.120	0.013	1017.08
SEm(±)	<b>1.785</b>	<b>0.456</b>	<b>0.006</b>	<b>0.001</b>	<b>0.948</b>
LSD (0.05)	<b>0.601</b>	<b>0.154</b>	<b>0.017</b>	<b>0.002</b>	<b>2.815</b>
2020-2021					
Treatments	Root length (cm)	Shoot length (cm)	Fresh weight (g)	Dry weight (g)	Vigour index
T <sub>0</sub>	6.38	2.58	0.092	0.01	665.21
T <sub>1</sub>	11.29	2.87	0.148	0.016	1248.70
T <sub>2</sub>	11.28	2.78	0.141	0.015	1202.04
T <sub>3</sub>	10.68	3.13	0.135	0.014	1153.22
T <sub>4</sub>	8.74	2.62	0.113	0.012	894.91
T <sub>5</sub>	9.53	2.65	0.112	0.012	972.35
T <sub>6</sub>	9.88	2.67	0.127	0.013	1030.53
T <sub>7</sub>	11.90	3.34	0.190	0.017	1399.59
T <sub>8</sub>	11.30	3.03	0.162	0.017	1284.16
T <sub>9</sub>	9.48	3.03	0.120	0.013	1005.18
SEm(±)	<b>1.243</b>	<b>0.474</b>	<b>0.001</b>	-	<b>1.524</b>
LSD (0.05)	<b>0.419</b>	<b>0.160</b>	<b>0.003</b>	<b>0.001</b>	<b>4.528</b>

Note: T<sub>0</sub> = Control, T<sub>1</sub> = Moringa leaf extract, T<sub>2</sub> = 1% NaCl, T<sub>3</sub> = 10% Polyethylene glycol (PEG), T<sub>4</sub> = 100 ppm GA<sub>3</sub>, T<sub>5</sub> = 5% KNO<sub>3</sub>, T<sub>6</sub> = 1000 ppm Thiourea, T<sub>7</sub> = Distilled water, T<sub>8</sub> = 2% KH<sub>2</sub>PO<sub>4</sub>, T<sub>9</sub> = 93 ppm NAA

### 3.2.8 Field emergence (%), Seedling length (cm) and Field vigour

All the parameters recorded in a nursery bed under poly-house condition such as, field emergence percentage, length of seedling and vigour index showed significant variation for priming materials during both 2019-2020 and 2020-2021. Highest magnitude of seedling emergence was recorded in T<sub>7</sub>, i.e., 89.67% in first and 86.67% in the second year, followed by T<sub>8</sub>, T<sub>1</sub>, T<sub>2</sub>, though T<sub>1</sub> and T<sub>2</sub> were statistically non-significant for the trait in second year, while it was lowest for T<sub>0</sub> in both years almost similar to the germination percentage observed under laboratory condition (Table 3.). Inhibition of germination due to deficit of water was alleviated by using hydro-primed lentil seeds (26). T<sub>7</sub> (18.08 cm and 18.90 cm) in two consecutive years, showed longest seedling length, while T<sub>7</sub> and T<sub>8</sub> showed non-significant difference amongst them in the character and followed by T<sub>1</sub> during both the years. It was recorded minimum for T<sub>0</sub> in both the years. Hydro-priming produced highest root and shoot length in rice at 30 days after sowing (27). T<sub>7</sub> (1621.47 in first and 1637.71 in the second year) resulted in the highest field vigour index compared with all other treatments including control. Seed hydro-priming potentially improved seed germination and vigour traits in wooly pod vetch under both laboratory and greenhouse condition (31). All the cases, T<sub>7</sub> and T<sub>8</sub> showed best performance than other priming materials. But, some cases T<sub>7</sub> and T<sub>8</sub> were non-significant variation in field condition also.

**Table 3. Influence of seed priming on the field vigour of Tomato**


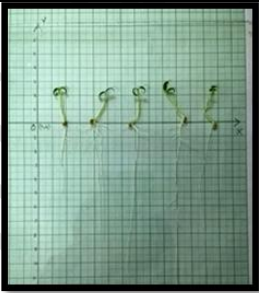

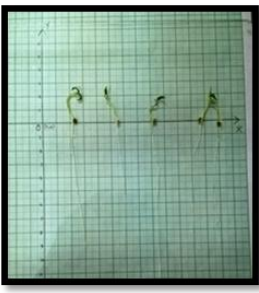


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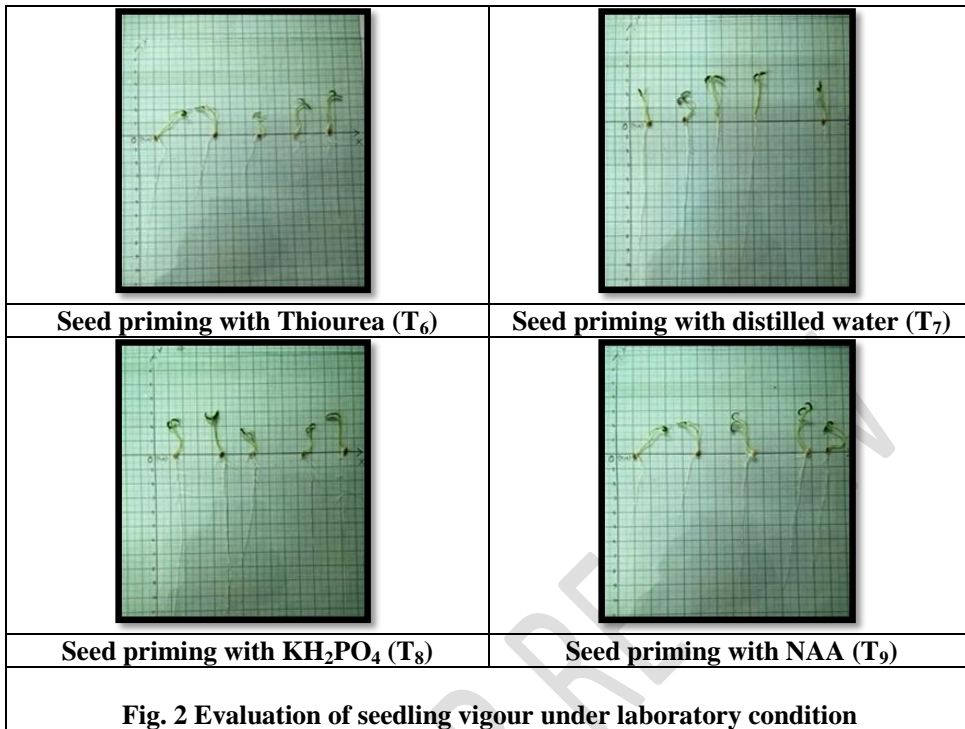
2019-2020			
Treatments	Field emergence (%)	Seedling length (cm)	Vigour index
T <sub>0</sub>	58.24 (72.33)	9.54	690.30
T <sub>1</sub>	67.74 (85.67)	16.99	1455.76
T <sub>2</sub>	66.40 (84.00)	16.24	1363.88
T <sub>3</sub>	65.13 (82.33)	14.45	1189.99
T <sub>4</sub>	59.11 (73.67)	12.02	885.47
T <sub>5</sub>	60.20 (75.33)	13.14	989.88
T <sub>6</sub>	62.70 (79.00)	13.79	1089.41
T <sub>7</sub>	71.24 (89.67)	18.08	1621.47
T <sub>8</sub>	69.13 (87.33)	17.56	1533.57
T <sub>9</sub>	61.09 (76.67)	13.27	1017.37
<b>SEm(±)</b>	<b>0.486</b>	<b>0.325</b>	<b>7.369</b>
<b>LSD (0.05)</b>	<b>1.454</b>	<b>0.974</b>	<b>22.063</b>
2020-2021			
Treatments	Field emergence (%)	Seedling length (cm)	Vigour index
T <sub>0</sub>	56.98 (70.33)	9.56	672.62
T <sub>1</sub>	66.14 (83.67)	17.87	1495.40
T <sub>2</sub>	65.88 (83.33)	16.39	1365.56
T <sub>3</sub>	64.13 (81.00)	15.13	1225.53
T <sub>4</sub>	57.61 (71.33)	12.42	885.96
T <sub>5</sub>	59.76 (74.67)	13.50	1008.00
T <sub>6</sub>	61.77 (77.67)	13.95	1083.19
T <sub>7</sub>	68.58 (86.67)	18.90	1637.71
T <sub>8</sub>	67.19 (85.00)	18.46	1569.38
T <sub>9</sub>	60.20 (75.33)	13.55	1020.52
<b>SEm(±)</b>	<b>0.429</b>	<b>0.157</b>	<b>7.26</b>
<b>LSD (0.05)</b>	<b>1.284</b>	<b>0.472</b>	<b>21.736</b>

**Note:** T<sub>0</sub> = Control, T<sub>1</sub> = Moringa leaf extract, T<sub>2</sub> = 1% NaCl, T<sub>3</sub> = 10% Polyethylene glycol (PEG), T<sub>4</sub> = 100 ppm GA<sub>3</sub>, T<sub>5</sub> = 5% KNO<sub>3</sub>, T<sub>6</sub> = 1000 ppm, Thiourea, T<sub>7</sub> = Distilled water, T<sub>8</sub> = 2% KH<sub>2</sub>PO<sub>4</sub>, T<sub>9</sub> = 93 ppm NAA

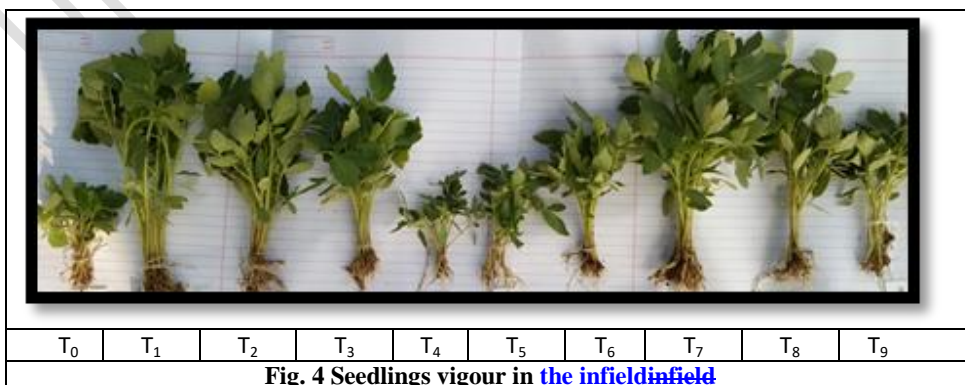


**Fig. 1** Different seed priming chemicals

	
<b>Control (T<sub>0</sub>)</b>	<b>Seed priming with MLE (T<sub>1</sub>)</b>
	
<b>Seed priming with NaCl (T<sub>2</sub>)</b>	<b>Seed priming with PEG (T<sub>3</sub>)</b>
	
<b>Seed priming with GA<sub>3</sub> (T<sub>4</sub>)</b>	<b>Seed priming with KNO<sub>3</sub> (T<sub>5</sub>)</b>



**Fig. 3 Seedlings in nursery beds**



#### 4. CONCLUSION

The field emergence was lower than laboratory germination but [the](#) field vigour index value was quite greater than laboratory vigour index as the field seedlings were absorbed some amount nutrients from soil. So, field seedlings were vigorous than laboratory seedlings. All the cases, hydro-priming and  $\text{KH}_2\text{PO}_4$  were best performer than other priming materials. So, it can be concluded that at [the](#) initial stage of growth plant hydro-priming and  $\text{KH}_2\text{PO}_4$  play the best performance than other priming materials.

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**Comment [DS24]:** Follow pattern of journal. Correct the all references according to journal pattern. Check all references are traceable to put on the DOI at the end of each reference.

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