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Effect of seed priming on seed quality enhancement in high and low vigour seed lots of tomato (*Lycopersicum esculentum*) var. PKM 1

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Abstract
Seed quality enhancement through seed priming was attempted in two different vigour level lots of tomato (*Lycopersicum esculentum*) var. PKM 1 at the Department of Seed Science and Technology, Agricultural College and Research Institute, Madurai. Two seed lots with the initial seed germination of 79 and 44 per cent and the vigour of 1610 and 539, designated as high and low vigour lots, respectively were selected and subjected to different seed priming treatments viz., hydropriming, GA_3 50 ppm, KNO_3 1%, KH_2PO_4 4%, succinic acid 300 ppm. The results revealed that the seed priming treatments have significant role in seed quality enhancement as evidenced by the germination improvement from 79 to 92 per cent by succinic acid 300 ppm and the vigour improvement from 1610 to 2243 in the high vigour lot. In the low vigour lot, the germination improvement from 44 to 72 per cent and vigour improvement from 539 to 1348 was recorded using KH_2PO_4 and the succinic acid 300 ppm recorded 68 per cent germination and 1104 vigour index.

Keywords: Tomato, seed priming, KH_2PO_4, Succinic acid, germination, vigour enhancement

Introduction
Tomato (*Lycopersicum esculentum*) is a seed propagated crop, cultivated extensively for its nutritious and edible fruits. Seed vigour decides the speed of germination and uniformity in seedling emergence. Consequence to germination, good crop establishment is a major constraint in the varied agro climatic and soil conditions especially in the semi-arid tropics. The problem of slow germination, delayed emergence and insufficient stand establishment can be solved through many techniques and among them seed priming is of greater importance.

Seed priming is a controlled hydration process that involves exposing seeds to low water potentials that restrict germination, but permits-germination and physiological changes to occur upon rehydration, primed seeds may exhibit faster rate of germination, more uniform emergence and greater tolerance to environmental stresses. It is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance (Taylor and Harman, 1990) [26]. Priming allows seed hydration to initiate the early events of germination, but not permit radicle emergence, followed by drying to initial moisture (Ashraf and Foolad, 2005) [3]. Upon subsequent rehydration, seeds show improved seed quality parameters such as reduced time to radicle emergence, synchronization of germination, greater percentage of germination and improved the seed vigour.

Hence, the present study aimed to tap the opportunity of using this seed priming as a tool to improve the germination as well the vigour of the low vigour seed lot. So that the low vigour and sub standard lots can be used successfully in the crop cultivation. Since tomato is low volume and high value crop, developing technologies which can help in effective utilization of every single seed, will bring greater practical utility.

Materials and Methods
Two seed lots of tomato var. PKM1 were analysed for its moisture content (%), initial germination (%), root length (cm), shoot length (cm), speed of germination, dry matter production of seedlings, and vigour index at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Madurai. After this initial evaluation, the seed lots were subjected to the seed priming treatments viz., hydropriming, GA_3 50 ppm, KNO_3 1%, $KH_2PO_4$4%, succinic acid 300 ppm.

Hydration with the different chemicals was done for 25 hours. This was standardized with the preliminary evaluation for standardizing the imbibition duration. In this evaluation, it was noticed that both the lots recorded the radical protrusion on 28 hours of imbibition. The visible symptom of radical protrusion on 28 hours led the decision of stopping the imbibition on 25 hours, where just the initiation and not the actual protrusion taken place.

After the imbibition with different chemical solutions, the imbibed seeds were removed from solutions, rinsed in water, whipped the peripheral moisture with the tissue paper, shade dried at room temperature for 8 hours and sundried upto the seeds attain the original moisture content.

These treated seeds along with control with three replication were subjected to the seed germination test following the procedures outlined by ISTA (1999). The germination test was conducted by following the procedure using paper medium and between paper method. Four replicates of 100 seeds each were germinated in a germination room maintained at 25 ± 2 °C temperatures and 95 ± 5% relative humidity. At the end of seventh day of sowing, the number of normal seedlings in each replication was counted and the germination was calculated and expressed in percentage.

Speed of germination

Four replicates of 100 seeds each were used to test the speed of germination of seeds from different treatments. The seeds showing radicle protrusion were counted daily after sowing until seventh day. From the number of seeds germinated on each day, the speed of germination was calculated using the following formula and the results were expressed in number (Maguire, 1962).

$$\text{Speed of germination} = \frac{X_1}{Y_1} + \frac{X_2 - X_1}{Y_2} + \frac{Xn - (Xn - 1)}{Yn} + \ldots\ldots\ldots\ldots\ldots + \ldots..$$

Where, X_1- number of seeds germinated at first count, X_2- number of seeds germinated at second count, Xn- number of seeds germinated on n^{th} day, Y_1-number of days from sowing to first count, Y_2- number of days from sowing to second count, Yn- number of days from sowing to n^{th} count.

Root length

At the time of germination count, 10 normal seedlings were selected at random from each replication and used for measuring the root length of seedlings. Root length was measured from the point of attachment of seed to the tip of primary root. The mean values were calculated and expressed in centimeter.

Shoot length

The seedlings used for measuring root length were also used for measuring shoot length. The shoot length was measured from the point of attachment of seed to the tip of the leaf and the mean values were expressed in centimeter.

Dry matter production

Ten normal seedlings were placed in a paper cover and dried in the shade for 24 h and then, they were kept in an oven maintained at 103 ± 2 °C for 16 ± 1 h. The dried seedlings were weighed and the mean values were expressed in g 10 seedlings^{-1}.

Vigour index

Vigour index values were computed using the following formulae and the mean values were expressed in whole number (Abdul-Baki and Anderson, 1973) [1].

Vigour index I = Germination percentage × (Root length + Shoot length).

Vigour index II = Germination percentage x Dry matter production.

Statistical analysis

The data obtained from different experiments were analyzed for the 'F' test of significance following the methods described by Panse and Sukhatme (1985) [20].

Result and Discussion

Germination percentage

Seed priming treatments have significant role in seed quality enhancement in terms of germination improvement, speed of germination, root length and shoot length of the seedlings, vigour index of the seedlings.

Seed priming with succinic acid 100 ppm improved the seed germination from 79 per cent to 92 per cent and from 44 per cent to 68 per cent in two different lots. Thus the germination improvement over the control in two different lots are 13 and 24 per cent respectively. This germination improvement may be due to the enhanced oxygen uptake, increased amylase activity and the efficiency of mobilizing nutrients from the cotyledons to the embryonic axis.

However, in the low vigour seed lot, seeds primed with the KH_2PO_4 has recorded the higher germination of 72% on comparative to the control (44%) with the germination improvement of 28 %. Increased germination in KH_2PO_4 priming in the low vigour seed lot might be due to ions absorption by seeds as reported by Alvarado *et al*. (1987). Moreover, the potassium salts had been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle (Bewley and Black, 1982). Enzymes such as amylases, proteases and in some cases lipases play vital roles in the early growth and development of embryo. Kausar *et al.*, (2009) observed effectiveness of priming with KH_2PO_4 in all germination related parameters in low vigour sunflower seeds. Priming of normal/low-vigor seeds improved the vigor of seedling in term of radicle length, plumule length and their root/shoot fresh weight.

A rapid resumption of DNA synthesis and initiation of cell division was observed in wheat soon after hydration (Dell'Aquila and Taranto,1986) while repair of DNA and other cellular components (e.g. membranes), which may be damaged during seed maturation, dehydration and storage, has been suggested to take place during seed priming. It has also been suggested that the onset or completion of DNA repair may be a major contributing factor to the improvement in germination after osmopriming (Burgass and Powell, 1984) [4].

Sivasubramanium *et al.*, (2011) opined that priming improves the longevity of low vigour seeds, but reduces that of high vigour seeds. The high vigour seed is at a more advanced physiological stage after priming nearly at stage III, and thus more prone to deterioration. When a low vigour seed is primed, it requires more time to repair the metabolic lesions incurred by the seed before any advancement in germination can occur, thus preventing further deterioration. Priming is also responsible to repair the age related cellular and subcellular damage of low vigor seeds that may accumulate during seed development (Bray, 1995) [5]. Priming of seed promotes germination by repair of the damaged proteins, RNA and DNA (Koehler *et al.*, 1997).

Root and shoot length

In the high vigour seed, priming with succinic acid 100 ppm recorded the high root and the shoot length of 15.61, 8.77 cm when compare to the control 13.16 and 7.21cm.This might be due to the vigour enhancement by using hormones as priming agent which lead to the increase in cell division within the apical meristem of seedling root, which caused an increase in seedling growth. Moreover, hormonal treatment maintains the IAA and cytokinin levels in the plant tissues, which enhances cell division (Demir. *et al.*, 1994) [7].

The seeds primed with KH_2PO_4 at 4% concentration, the low vigour seeds showed the higher high root and the shoot length than other priming treatments. It shows high root and the shoot length of 11.92 and 6.80 cm. Which might be due to the potassium salts reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle (Bewley and Black, 1982).

Speed of emergence and Vigor index I & II

Speed of emergence (12.75) and Vigor index I (2243) & II (2) were high with succinic acid 100 ppm seed priming for the seeds with the initial germination of 79 per cent, which was classified as high vigour lot followed by priming with GA_3 50 ppm.

Seed priming with GA_3 has been demonstrated to be a useful tool for activating metabolic germination processes and facilitating increments in physiological processes during seed germination. Seed priming using GA_3 at appropriate concentrations leads to high germination rates and better seedling growth; however, the beneficial concentration differs among plant species. (Dotto, 2017) [9].

In the low vigor lot, KH_2PO_4 recorded the high. Mehdi *et al*. 2012, stated that analyzing seed priming effects had demonstrated the influence of two substances i.e. KH_2PO_4 and $Cacl_2$ on MGT. As a result seed priming had caused to decreasing of MGT in a significant way with control. These results are in confirmation with that of Kester *et al.*, (1997) who reported priming with 3% KNO_3 decreased the MGT in aged and non aged tomato seeds.

The improvement is considered as regulators of plant growth including seed germination by enhancing expression of metabolites such as amylase and reducing sugars (Afzal *et al.*, 2012) [2].

Saeidi *et al.*, (2008) [21] reported that priming of canola with KH_2PO_4 1% obtained highest effect on RDW. These results are in line with the findings of Grandi *et al.*, (1999) [1] who also found the P enrichment by soaking seeds in 200 mM KH_2PO_4 solution improved the seedling establishment.

Similar findings were reported by Kumar *et al.*, (2013) [17] Saeedipour (2013) [22], Das *et al.*, (2014) [6], Khan *et al.*, (2011) [15], Sakhabutdinova *et al.*, (2003) [23], Afzal *et al.*, (2006) and *et al.*, (1977) [23].

Conclusion

It is concluded that seed priming have greater influence in seed quality enhancement in low vigour seed lots compared to high vigour seed lots. The response of chemicals influencing the quality enhancement may vary depends upon the initial quality of the seed. Nevertheless, the seed priming have positive influence on seed quality enhancement in tomato.

Table 1: Priming treatments on high vigour seeds of tomato

Treatment	Germination %	Shoot Length (cm)	Root length (cm)	Seedling length (cm)	Dry Matter Production g/10 seedling	Vigour Index I	Vigour Index II	Speed of Germination
Control	79 (62.75)	7.21	13.16	20.38	0.0149	1610	1	9.7
Hydro	80 (63.43)	8.28	13.47	21.75	0.0159	1740	1	9.8
GA_3 (50ppm)	88 (69.76)	8.61	14.48	23.09	0.0168	2032	1	12.15
KNO_3 (1 %)	84 (66.50)	8.07	15.28	23.35	0.0181	1961	2	10.95
KH_2PO_4 (2 %)	82 (64.88)	7.32	13.18	20.50	0.0132	1681	1	10.3
Succinic acid (300ppm)	92 (53.57)	8.77	15.61	24.38	0.0201	2243	2	12.75
Mean	84 (66.50)	8.04	14.19	22.24	0.01	1877	1.33	10.94
SEd	3.29	0.35	0.51	1.15	NS	92.50	NS	0.54
CD(.05)	7.35	0.78	1.13	2.57	NS	206.12	NS	1.20

Table 2: priming treatments on low vigour seeds of tomato

Treatment	Germination %	Shoot Length (cm)	Root Length (cm)	Seedling Length (cm)	Dry Matter Production g/10 seedling	Vigour Index I	Vigour Index II	Speed of Germination
Control	44 (41.55)	4.87	7.38	12.25	0.0137	539	1	6.8
Hydro	56 (48.44)	6.05	10.04	16.09	0.0146	900	1	7.1
GA3 (50 ppm)	64 (53.13)	5.81	9.83	15.64	0.0162	1000	1	9.6
KNO_3 (1%)	66 (54.33)	6.59	9.96	16.55	0.0157	1076	1	8.5
KH_2PO_4 (2%)	72 (58.05)	6.8	11.92	18.72	0.0175	1348	1	8.1
Succinic Acid (300ppm)	68 (54.33)	6.72	9.51	16.23	0.0166	1104	1	9.8
Mean	61.66	6.14	9.77	15.91	0.0157	994	1	8.3
SEd	4.33	0.16	0.52	1.11	NS	52.46	NS	0.52
CD(.05)	9.43	0.36	1.14	2.43	NS	114.14	NS	1.15

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