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Effect of different concentrations of kinetin on seed germination in tomato

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Key words: Osmopriming, Tomato, Seed germination, Seed priming, Seedling vigor.

Abstract

Fresh seeds of tomato cultivars Narc-2012 and Narc-2013 were subjected to osmopriming treatments with an objective to improve germination and seedling vigor by dormancy breakdown. For osmopriming seeds were soaked in aerated solution of 10, 50 and 100 ppm kinetin for 24 hours at 25°C. All the treatments resulted in improved germination and seedling vigor by dormancy breakdown compared with untreated seeds; however, highest vigor was observed in seeds subjected to 10 ppm kinetin followed by 50 ppm kinetin and 100 ppm kinetin.

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Introduction

Tomato (*Lycopersicon esculentum* L.) belonging to solanaceae and its origin is the Andean zone particularly Peru-Ecuador-Bolivian areas but cultivated tomato originated in Mexico. Tomato is one of the most highly praised vegetables consumed widely and it is a major source of vitamins and minerals. It is one of the most popular Salad vegetables and is taken with great relish. It is widely employed in cannery and made into soups conserves, pickles, ketchup, sauces, juices etc. Tomato juice has become an exceedingly popular appetizer and beverage. The well ripe tomato (per 100 g of edible portion) contains water (94.1%), energy (23 calories), calcium (1.0 g), magnesium (7.0 mg), vitamin A (1000 IU),ascorbic acid (22 mg), thiamin (0.09 mg), riboflavin (0.03 mg) and niacin (0.8 mg). Plant growth regulators are essential for growth and development of tomato plant (Salunkhe *et al.,* 1987*).* Cytokinins comprise a separate class of growth substances and growth regulators. They produce various effects when applied to intact plants. They particularly stimulate protein synthesis and participate in cell cycle control. It is perhaps for this reason that they can promote the maturation of chloroplasts and delay the senescence of detached leaves. Cytokinin application to a single site in the plant (e.g. to one leaf) causes the treated organ to become an active sink for amino acids, which then migrate to the organ from surrounding sites. The effect of cytokinins is most noticeable in tissue cultures where they are used, often together with auxins, to stimulate cell division and control morphogenesis. Added to shoot culture media, these compounds overcome apical dominance and release lateral buds from dormancy.

Seed priming is a pre-sowing seed treatment used for improving seed germination properties of many crops particularly seeds of vegetables and small seeded crops (Bradford, 1986*).* Appropriate priming treatments also synchronize seedling emergence and improve field performance in many crop species *(*Nakaune *et al.,* 2012*;* Heydekker *et al.,* 1973*).* During priming, seeds are partially hydrated so that pre-germinative metabolic activities proceed while radical protrusion is prevented *(*Mc Donald*,* 2000). Initiating germination processes before sowing induced by priming enhance germination of crops (Sadeghian and Yavari, 2004; Khajeh-Hosseini *et al.*, 2003; Ghassemi-Golezani and Esmaeilpour, 2008; Parera and Cantliffe, 1994*).*

Tomato is among the crops which are responsive to priming. The rationale of seed priming is to lessen the time between planting and emergence and to protect seeds from biotic and abiotic factor during critical phase of seedling establishment and to synchronize emergence, which leads to uniform stand as well as improved yield. These priming treatments which enhance seed germination include hydropriming (Afzal *et al.,* 2002) osmopriming (*Rouhi,* 2011*),* solid matrix priming (Ghassemi-Golezani *et al.,* 2010*)* halopriming *(*Nawaz *et al.,* 2011*)* and hormonal priming (Afzal *et al., 2011).* Cytokinins can also be used as priming agent; they are mainly involved in the breakdown of dormancy of some seeds, (Arteca, 1996). In this priming the seeds are soaked in aerated solution, which helps to invigorate the seed and facilitate the process of seed germination and seedling emergence evenly under adverse environmental conditions.

Primed seeds perform better in a wider range of temperatures and are less sensitive to oxygen deprivation (Corbineau *et al.,* 1993) than unprimed ones. The favorable impact of priming has been associated with various, cellular, molecular and biochemical events including synthesis of DNA and proteins (Bewley and Black*,* 1994*).* Priming can also help to increase enzyme activity and neutralize the effects of seed ageing. Priming techniques has been reported to help in dormancy breakdown in many vegetable crops including tomato (Bradford, 1986; Liu *et al., 1996;* Kester *et al., 1997).*

The present study was therefore planned to evaluate the impact of osmopriming techniques (if any) on the germination and seedling vigor, and dormancy breakdown of tomato.

Materials and methods

Plant material

Seeds of two tomato cultivars i.e. NARC-2012 and NARC-2013 were collected from National Agriculture Research Council, Islamabad, Pakistan.

Methodology

Seeds were surface sterilized. These surface sterilized seeds were soaked in aerated solution of 10, 50 and 100 ppm kinetin for 24 hours at 25°C.The solution of kinetin was prepared while treating it with 1M NaOH. 1M NaOH was prepared by taking 1 gram of NaOH and dissolving it in 25ml of distilled water. Kinetin solution was prepared by dissolving 1 gram of kinetin in 125ml of distilled water by adding 6-10 drops of NaOH Solution respectively.

Non primed seeds were considered as control. For hydro priming, seeds were soaked in distilled water. After respective priming treatment for specific period, seeds were washed with distilled water and dried at room temperature on filter paper in shade for 24 h. The concentration used for treatment was 10ppm, 50 ppm and 100ppm.

Germination test

Twelve seeds with three replicates per treatment were germinated at room temperature in Petri dishes on two layers of filter paper and moistened with 2 ml distilled water for 12 days.

Time to 50% germination (T50) was calculated according to the formulae of *Coolbear et al., (1984)*. Mean germination time (MGT) was calculated according to *Ellis and Roberts (1981)*.

Germination index (GI) was calculated as described in the AOSA (1983). Energy of germination was recorded 4th day after planting. It is the percentage of germinating seeds 4th day after planting relative to the total number of seeds tested.

$$T50 = \frac{\mathrm{ti} + \left(\frac{\mathrm{N}}{2} - \mathrm{ni}\right)(\mathrm{tj} - \mathrm{ti})}{\mathrm{nj} - \mathrm{ni}}$$

Where N is the final number of germination and ni, nj cumulative number of seeds germinated by adjacent counts at times ti and tj when ni <N/2<nj.

Mean germination time (MGT) was calculated according to the equation of Elis and *Roberts (1981)*:

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

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.

Germination Index (GI) was calculated as described in Association of official Seed Analysts (1983) as the following formulae:

$$G.I = \frac{\text{No of germinated seeds}}{\text{Days of first count}} + \frac{No\ of\ germinated\ seeds}{Days\ of\ second\ count} + \cdots + \frac{No\ of\ germinated\ seeds}{Days\ of\ final\ count}$$

Energy of germination was recorded 4th day after planting. It is the percentage of germinating seeds 4 days after planting relative to the total number of seeds tested (*Ruan et al., 2002)*.

Seedling emergence

Control and treated seeds were sown in plastic pots (12 in each) having moist sand, replicated three times and were placed in net house, Mean daily temperature was 25°C during the course of investigation.

Emergence was recorded daily according to the seedling evaluation Handbook of Association of Official Seed Analysts (1990). Mean emergence time was calculated according to the method described earlier.

Results and discussion

Osmopriming treatments significantly affected the germination vigor of all the tomato cultivars (Table 1).

The response of all the cultivars to the osmopriming treatments was similar (Table 1).

Table 1. Effect of osmopriming on the germination ability of tomato cultivars.

Treatments		FGP%	MGT(Days)	T50 (Days)	G.I
NARC- 2012	Control	77.77	7.77	6.25	4.108
	Osmopriming (10ppm) Kinetin	100	0.66	0.24	27
	Osmopriming (50ppm) Kinetin	86	8.6	5.35	11.527
	Osmopriming (100ppm) Kinetin	50	7	5	10.055
NARC- 2013	Control	52.77	5.27	5.37	2.524
	Osmopriming (10ppm) Kinetin	86	2.58	1.29	26.33
	Osmopriming (50ppm) Kinetin	69.40	6.94	4.88	17.327
	Osmopriming (100ppm) Kinetin	53	5.2	5.5	13.747

All the seed treatments resulted in lower T_{50} and MGT and higher FGP, GI was compared with untreated seeds (Table 1). In all the cultivars lowest T_{50} was noted in seeds osmoprimed with kinetin 10 ppm that was followed by 50ppm and 100ppm in Narc-2012 and Narc-2013 respectively. (Table 1) (Fig. 2). Minimum MGT was noted in seeds subjected to 10ppm kinetin in all the cultivars (Table 1) (Fig. 4). Maximum FGP, $T_{50,}$ GI and MGT were noted in seeds osmoprimed with 10 ppm kinetin in all the cultivars (Table 1) (Fig. 1; Fig. 2; Fig.3; Fig. 4). Significant effect of osmopriming treatments on the seedling vigor of all the tomato cultivars was observed (Table 2).

Table 2. Effect of osmopriming on seedling vigor of tomato cultivars.

Treatments		MET (days)	FEP (%)	Root length (cm)	Shoot length (cm)
NARC- 2012	Control	17.5	19.6	54	44.67
	Osmopriming (10ppm) Kinetin	12	22	58	49
	Osmopriming (50ppm) Kinetin	12	27	44	37
	Osmopriming (100ppm) Kinetin	6	31	36	28
NARC- 2013	Control	8.2	20	48	46.67
	Osmopriming (10ppm) Kinetin	8.2	25	53	51.45
	Osmopriming (50ppm) Kinetin	8	30	48	44.98
	Osmopriming (100ppm) Kinetin	9	33	40	37.78

All the seed treatments resulted in lower MET compared with control while Narc-2012 behaved similar to that of untreated seeds (Table 2).

In all the cultivars, all the seed treatments resulted in higher FEP, root and shoot length compared with control (Table 2). Tomato seeds subjected to 10 ppm kinetin osmopriming resulted in highest FEP, root and shoot length compared with all other treatments including control.

Osmopriming had significant effect on the germination seedling vigor in tomato cultivars used in the present investigation (Tables 1, 2) (Fig. 1).

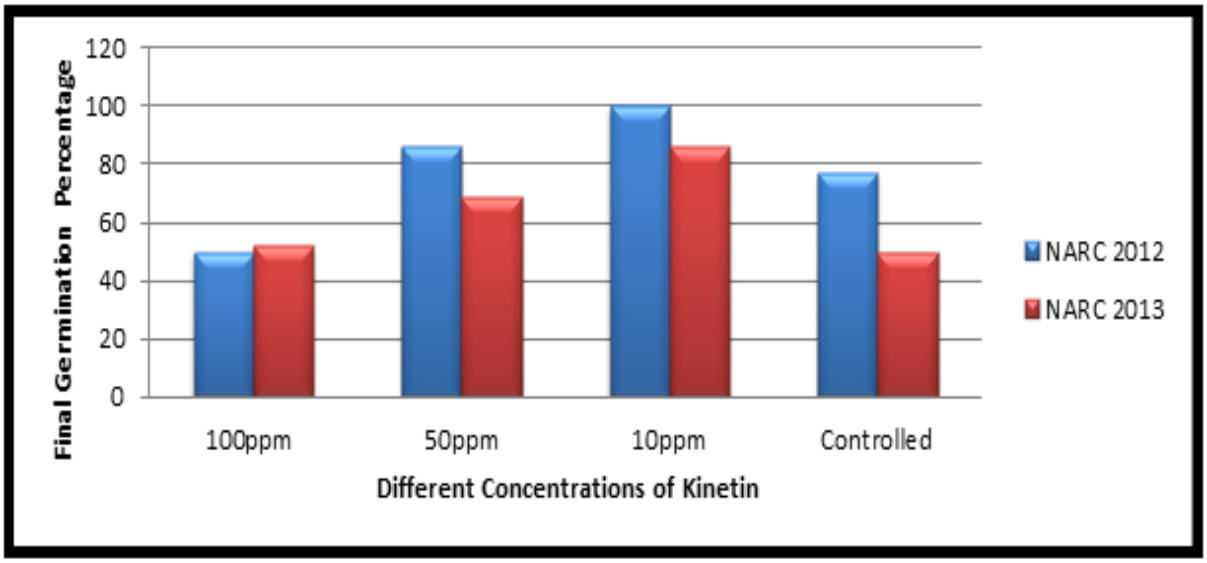

Fig. 1. Effect of various concentration of kinetin on seed germination of tomato varieties.

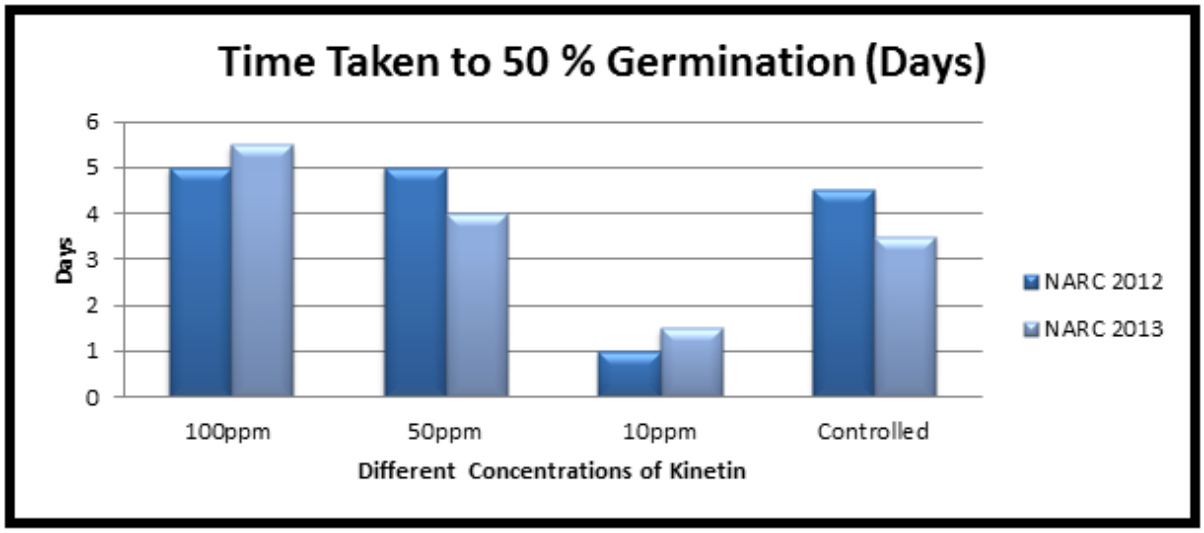

Fig. 2. Effect of different concentrations of kinetin on days to 50% germination.

Response of all tomato cultivars to different osmopriming treatments was similar (Tables 1, 2) (Fig. 1). Earlier and synchronized germination and emergence was observed in the treated seeds compared with that of control as depicted by lower MET, T50 and MGT, and higher GI, FEP, FGP in treated seeds compared with untreated ones (Tables 1, 2), which is primarily attributed to dormancy breakdown as fresh seeds were used and dormancy has been reported in freshly harvested tomato seeds (Liu *et al.,* 1996). Higher root and shoot length was observed in treated seeds might be the result of earlier germination and emergence (Tables 1, 2). Osmopriming has been found to improve germination rate and speed in tomato especially when freshly harvested seeds are used (Liu *et al.,* 1996). Osmotically primed tomato seeds showed improved stand establishment, early seedling growth and yield, seedlings from primed seeds emerged earlier and more uniformly than seedlings from untreated seeds (Alvardo *et al.,* 1987). Enhanced seed germination and improved seedling performance has also been recorded in freshly harvested tomato seeds compared with the untreated control (Liu *et al., 1996).* The earlier and better synchronized germination is associated with increased metabolic activities in the osmoprimed seeds (Alvardo *et al.,* 1987; Liu *et al.,* 1996).

Faster emergence rate after osmopriming may be explained by an increased rate of cell division in the root tips as previously found for wheat (Bose and Mishra, 1992). In earlier studies, it was observed that seedlings from primed tomato seeds maintained greater mean plant dry weights, leaf areas and ground cover percentage than untreated seedlings throughout the pre-flowering period (Alvardo *et al.,* 1987). The beneficial aspects of priming are primarily due to pre enlargement of the embryo (Khan, 1992), and Improvement of germination rate (Gray and Steckle, 1977).

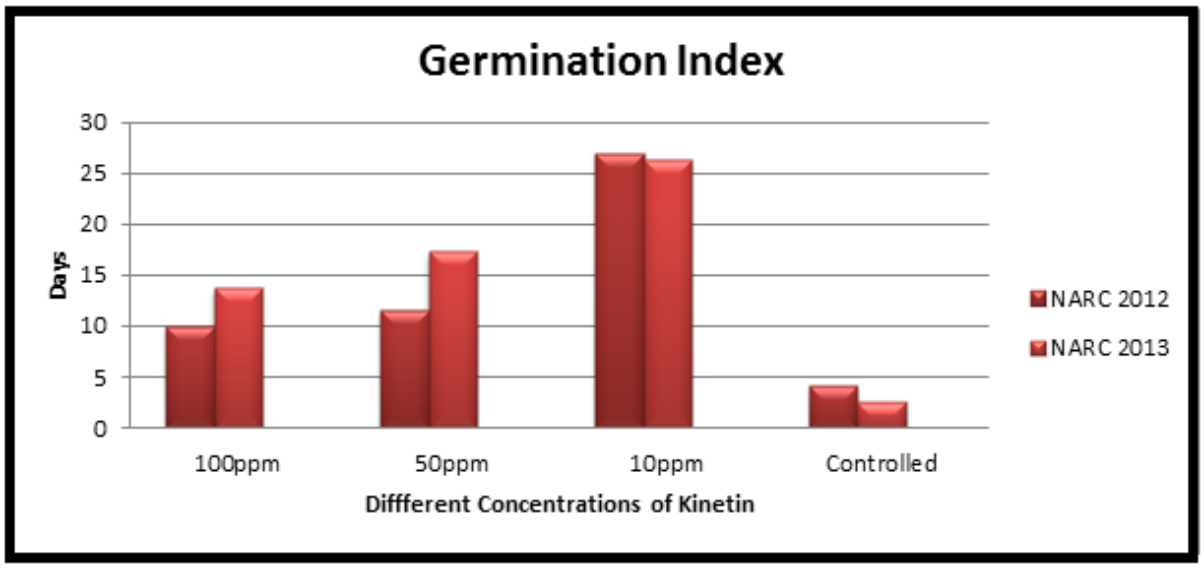

Fig. 3. Effect of different concentrations of kinetin on germination index of tomato.

From the present investigation it may be concluded that germination and seedling vigor can be enhanced by osmopriming treatments in different tomato cultivars by dormancy breakdown. However osmopriming with kinetin was more effective than hydro priming.

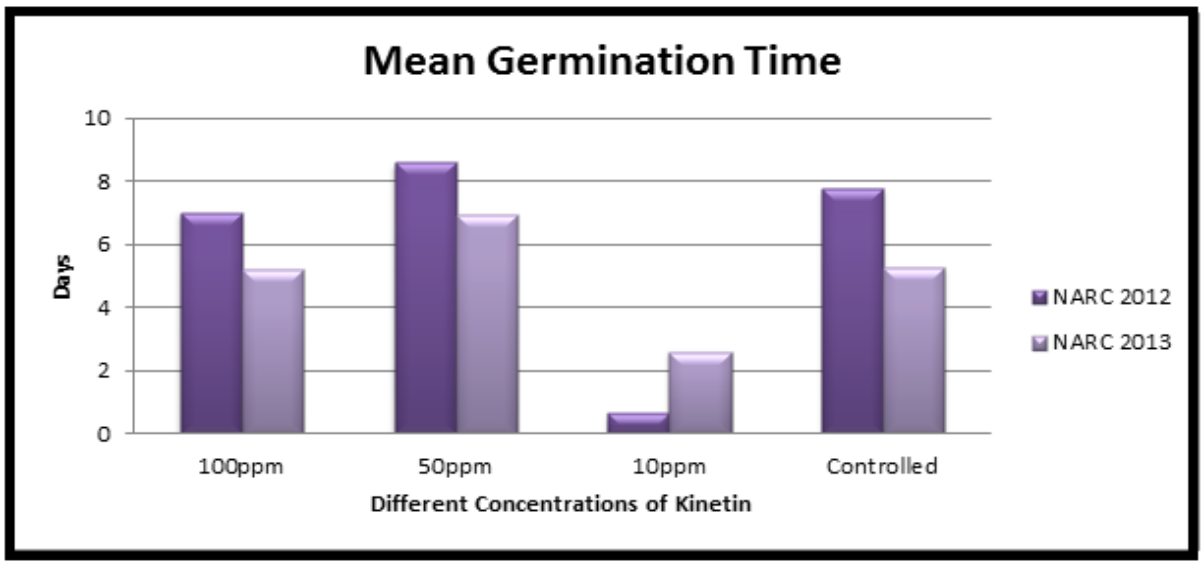

Fig. 4. Effect of different concentration of kinetin on mean germination time.

Conclusion

From this study it can be concluded that germination and seedling vigor may be enhanced by seed pretreatment with kinetin in both the tomato cultivars NARC-2012 and NARC-2013.However, kinetin with 10 ppm was more effective than all other kinetin treatments.

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Abbreviations

Mean germination time = MGT, Mean emergence time = MET, Speed of germination index = GI, Time taken for 50 % germination = T_{50}, Final germination percentage = FGP, Final emergence percentage = FEP

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