

Original Research Article

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Comparative Study of Magnetic, Electric and Botanical Seed Treatments on Seedling Characters of Tomato (*Solanum lycopersicum* L.)

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ABSTRACT

The experiment was conducted to standardize the best treatment of electromagnetic and botanicals for Tomato (PKM-1). Three methods of priming viz-magnetopriming, electropriming, and organicpriming with control (Unprimed) were evaluated by screening different duration (15 minutes, 30 minutes, 6 hours and 12 hours) and different concentrations viz., T₀-Unprimed (Control), magneto-priming - T₁-200 gauss @ 15 minutes, T₂-200 gauss @ 30 minutes, T₃-400 gauss @ 15 minutes, T₄-400 gauss @ 30 minutes, electro-priming- T₅- 100 mA @ 15 minutes, T₆- 100 mA @ 30 minutes, T₇- 200 mA @ 15 minutes, T₈- 200 mA @ 30 minutes, organic-priming- T₉- Neem Leaf Extract (10%) @ 6 hours, T₁₀- Neem Leaf Extract (10%) @ 12 hours, T₁₁- Tulsi Leaf Extract (10%) @ 6 hours, T₁₂- Tulsi Leaf Extract (10%) @ 12 hours. The study revealed that the seed treatment with magneto-priming (T₄-400 gauss @ 30 minutes), (T₃-400 gauss @ 15 minutes) and organic-priming (T₁₀- Neem leaf extract (10%) @ 12 hours) recorded better performance in maximum seed quality parameters as compared to other treatments and control on the basis of lab studies.

Keywords

Tomato, Priming, Gauss, Neem and Tulsi leaf extract

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Introduction

Tomato (*Solanum lycopersicum* L.) is an important vegetable crop and which has the chromosomal number of $2n = 24$. It is the annual herb and it is Self-pollinated crop. It has a significant role in human nutrition in human diet (Fekadu *et al.*, 2004) and belonging to Solanaceae family, and to the order solanales. Its origin is the Andean zone particularly Peru-Ecuador-Bolivian areas but

cultivated tomato originated in Mexico. The Spanish introduced the tomato into Europe in the early 16th century and the mid-16th century tomatoes have been cultivated and consumed in southern Europe, though they only became wide spread in north-western Europe by the end of the 18th century (Harvey *et al.*, 2002).

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 (per100g of edible portion) contains water (94.1%), energy (23calories), calcium (1.0g), magnesium (7.0mg), vitamin A (1000IU), ascorbic acid (22mg), thiamin (0.09mg), riboflavin(0.03mg) and niacin (0.8mg) (Uddain *et al.*, 2009).

Priming is water-based process, performed on seeds to increase germination uniformity & thus enhances vegetable stand establishment. Seed priming is a low cost & low risk invention, used to overcome poor stand establishment. The rationale of seed priming is to lessen the time between planting and emergence and to protect seeds from biotic and abiotic factors during critical phase of seedling establishment and to synchronize emergence, which leads to uniform stand as well as improved yield (Krishnaswami and Srimarathi, 2001). Priming is controlled hydration technique and enhances seed performance by increasing germination rate and uniformity resulting in faster and better seedling development in various crops (Powell *et al.*, 2000, Afzal *et al.*, 2011). Leaves of the plant contain alkaloids and phenolic compounds which protect the plants against pathogens and also produce antioxidant activity (Satish *et al.*, 2007).

Magnetic and electromagnetic treatments are being used in agriculture, as a noninvasive technique, to improve the germination of seeds and increase crops and yields (Martmez *et al.*, 2009). Researchers consider that the prospect of using cheap magnetic energy to improve the properties of soil and plant growth and development may be of great practical importance (Mohamed and Ebead, 2013). Magnetic field has been found to improve food reserve utilization and help for better absorption and assimilation of nutrients by plants (P. kavi, 1977) and photosynthetic activities (Lebedev *et al.*, 1977). The choice of the investigated plants is based mainly on the

importance they have. It has been found that the percent germination rates of the treated tomato seeds were accelerated about 1.1 to 2.8 times compared with that of the untreated seed, while an inhibitory effect on germination was shown in the case of the electric field more than 12 kV/cm and the exposure time more than 60 seconds (Moon and Chung, 2000).

So keeping these aspects in view the present experiment entitled Comparative study of magnetic, electric and botanical seed treatments on seedling characters of Tomato (*Solanum lycopersicum L.*) was carried out with following objectives:

To determine the effect of different pre-sowing Seed treatment of magnetic field, electric field and botanicals on seedling characteristics and to identify the suitable Pre-sowing Seed treatment of electric field, magnetic field and botanicals on seedling behaviour of tomato seeds.

Materials and Methods

The experiment was conducted in Post Graduate Laboratory, Department of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) Tomato (PKM-1). In this experiment different (15 minutes, 30 minutes, 6 hours and 12 hours) duration on different concentrations viz., T₀-Unprimed (Control), T₁-200 gauss @ 15 minutes, T₂-200 gauss @ 30 minutes, T₃-400 gauss @ 15 minutes, T₄-400 gauss @ 30 minutes, T₅- 100 mA @ 15 minutes, T₆- 100 mA @ 30 minutes, T₇- 200 mA @ 15 minutes, T₈- 200 mA @ 30 minutes, T₉- Neem Leaf Extract (10%) @ 6 hours, T₁₀- Neem Leaf Extract (10%) @ 12 hours, T₁₁- Tulsi Leaf Extract (10%) @ 6 hours, T₁₂- Tulsi Leaf Extract (10%) @ 12 hours were used. After cleaning and grading, the seeds of tomato were soaked in respective

priming solutions at different volume of seeds for fifteen minutes, thirty minutes, six hours and twelve hours. Then the seeds were air dried under the shade to bring back to their original moisture content and used for sowing.

Preparation of solution

For the preparation of the Botanical solution (Tulsi and Neem leaf extract), 10 gram of each were taken in a beaker filled with 1000 ml. of distilled water accompanied by constant stirring. The volume of solution was then finally constituted to one liter and hence 1% stock solution of each chemical was prepared. The flasks containing chemicals were covered with muslin cloth to avoid any contamination.

Magnetic Field

An electromagnetic field generator “Testron EM-20” with variable static magnetic field (SMF) strength (50 to 500 mT) with a gap of 5 cm between pole pieces was fabricated. A D.C. power supply (80V/10A) with continuously variable output current was used for the electromagnet.

A digital gauss meter model DGM-30 operating on the principle of Hall Effect monitored the field strength produced in the pole gap. The probe is made of Indium Arsenide to crystal and was encapsulated to a non-magnetic sheet of 5 mm x 4 mm x 1 mm which was able to measure 0-2 Tesla with full-scale range in increments of 5 MT. By regulating the current in the coils, desired strength of SMF was monitored, which was measured by a Gauss meter. The strength and duration was standardized for maximum enhancement of germination and vigour of seeds.

The observation on the seedling characters *viz.*, Germination percent, Root length (cm), Shoot length (cm), Seedling length (cm),

Seedling Fresh weight (g), Seedling dry weight (g), Seedling Vigour index I, Seedling Vigour index II and electrical conductivity were recorded. The experimental data recorded were subjected to statistical analysis for calculating analysis of variance, range, mean, critical difference and coefficient of variation.

Results and Discussions

According to the results, all studied traits were affected by the treatments and there was completely significant difference between control (un-treated seed) and primed seeds (Table-1).

All seedling characters *viz.* Germination percent, Root length (cm), Shoot length (cm), Seedling length (cm), seedling fresh weight (g), seedling dry weight (g), Seedling Vigour index-I, Seedling Vigour index-II and electrical conductivity were affected by T₄ - 400 gauss @ 30 minutes significantly recorded maximum values whereas lowest was observed in T₀- Control (un-treated seed) (Table- 2).

Significantly higher germination percent (92.25%) reported in treatment T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (91.50%) and T₁₀- Neem leaf extract (90.50%). Minimum germination percent was recorded in T₀- Control (80.25%).

The maximum root length (8.39 cm) was recorded by T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (8.02 cm) and T₁₀- Neem Leaf Extract (7.67 cm). Minimum root length recorded in T₀- Control (3.85 cm).

The maximum shoot length (12.15 cm) recorded by T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (11.74 cm) and T₁₀- Neem leaf extract (11.24

cm). Minimum shoot length was founded in T₀- Control (6.44 cm).

The maximum seedling length (20.54 cm) was recorded in T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (19.76 cm) and T₁₀- Neem leaf extract (18.91 cm). Minimum seedling length was recorded in T₀- Control (10.29 cm). The maximum seedling fresh weight (32.40 mg) was reported in T₄-400 gauss @ 30 minutes followed by T₃-

400 gauss @ 15 minutes (30.85 mg) and T₁₀-Neem Leaf Extract (29.85 mg). Minimum seedling fresh weight was found in T₀-Control (18.77 mg).

The maximum seedling dry weight (10.72 mg) was recorded in T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (10.22 mg) and T₁₀- Neem leaf extract (9.89 mg). Minimum seedling dry weight was found in T₀- Control (6.21 mg).

Treatment Details

Treatment	Intensity	Duration	Method of Priming
T ₀	-	-	-
T ₁	200 gauss	15 minutes	Magnetic
T ₂	200 gauss	30 minutes	Magnetic
T ₃	400 gauss	15 minutes	Magnetic
T ₄	400 gauss	30 minutes	Magnetic
T ₅	100 mA	15 minutes	Electric
T ₆	100 mA	30 minutes	Electric
T ₇	200 mA	15 minutes	Electric
T ₈	200 mA	30 minutes	Electric
T ₉	Neem leaf extract	6 hours	Organic
T ₁₀	Neem leaf extract	12 hours	Organic
T ₁₁	Tulsi leaf extract	6 hours	Organic
T ₁₂	Tulsi leaf extract	12 hours	Organic

Legends: T = Treatment

mA= milli amperes

Table.1 Analysis of variance for 9 seedling characters in Tomato

S. No.	Characters	Mean sum of squares	
		Treatments (df=12)	Error (df=39)
1.	Germination Percentage	62.68**	2.53
2.	Root Length	8.35**	0.14
3.	Shoot Length	13.69**	0.17
4.	Seedling Length	42.15**	0.21
5.	Seedling Fresh Weight	72.33**	0.12
6.	Seedling Dry Weight	7.84**	0.01
7.	Seedling Vigour Index I	488809.56**	3571.58
8.	Seedling Vigour Index II	95488.98**	248.53
9.	Electrical conductivity	0.012**	0.001

** significant at 5% level of significance

Table.2 Mean performance of tomato for 9 seedling characters

S. No.	Treatments	Germination %	Root Length (cm)	Shoot Length (cm)	Seedling Length (cm)	Seedling Fresh Weight (gm)	Seedling Dry Weight (gm)	Seedling Vigour Index I	Seedling Vigour Index II	Electrical Conductivity
1	T ₀	80.25	3.85	6.44	10.29	18.77	6.21	799.48	498.54	0.511
2	T ₁	85.50	5.90	8.81	14.71	24.58	8.11	1258.12	694.09	0.396
3	T ₂	86.75	6.28	9.29	15.57	25.70	8.50	1351.19	737.84	0.392
4	T ₃	91.50	8.02	11.74	19.76	30.85	10.22	1808.97	935.62	0.321
5	T ₄	92.25	8.39	12.15	20.54	32.40	10.72	1896.01	989.19	0.318
6	T ₅	81.50	4.35	6.91	11.26	20.41	6.75	918.72	550.30	0.474
7	T ₆	82.25	4.71	7.39	12.10	21.27	7.04	994.91	579.05	0.464
8	T ₇	83.50	5.17	8.02	13.19	21.85	7.39	1102.05	617.21	0.420
9	T ₈	84.50	5.55	8.44	13.99	23.62	7.81	1181.81	660.32	0.413
10	T ₉	89.75	7.35	10.70	18.06	28.56	9.46	1621.21	849.28	0.371
11	T ₁₀	90.50	7.67	11.24	18.91	29.85	9.89	1712.06	895.10	0.368
12	T ₁₁	87.50	6.60	9.78	16.38	26.78	8.85	1433.60	774.84	0.380
13	T ₁₂	89.00	6.95	10.25	17.20	27.55	9.12	1531.43	812.24	0.377
Grand Mean		86.51	6.21	9.32	15.53	25.55	8.47	1354.58	737.97	0.400
C.D.(5%)		2.27	0.53	0.59	0.66	0.51	0.15	85.47	22.56	0.050
SE(m)		0.79	0.18	0.20	0.23	0.17	0.05	29.88	7.88	0.017
C.V.		1.83	5.02	4.45	3.00	1.39	1.23	4.41	2.13	5.87

The maximum seedling vigour index-I (1896.01) was recorded in T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (1808.97) and T₁₀- Neem Leaf Extract (1712.06). Minimum seedling vigour index-I was recorded in T₀- Control (799.48).

The maximum seedling vigour index-II (989.19) was recorded in T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (935.62) and T₁₀- Neem Leaf Extract (895.10). Minimum seedling vigour index-II was recorded in T₀- Control (498.54).

The minimum electrical conductivity (0.318) was recorded in T₄-400 gauss @ 30 minutes followed by T₃-400 gauss @ 15 minutes (0.321) and T₁₀- Neem leaf extract (0.368). Maximum electrical conductivity was recorded in T₀- Control (0.511).

Fresh weight were higher in plants treated with magnetic treatment. A. Abou *et al.*, (2012). Pre-sowing treatment of corn seeds with pulsed EMFs 30 min improved plant fresh and dry weight. Seeds that have been exposed to MF for 30 min have been found to perform the best results with economic impact on producer's income in a context of a modern, organic, and sustainable agriculture (Bilalis *et al.*, 2012).

The primed seeds showed higher seed vigour index-I better germination pattern and higher vigour level than non- primed (Aksyonov *et al.*, 2001). Vashisth and Nagarajan (2010) revealed that vigor index (18-74%) of sunflower were increased at different magnetic fields compared with control treatment. Pre-sowing treatment with magnetic field in wheat seeds resulted in

higher germination and gluten content S. Pietruszewski, (1996). Moon and Chung, (2000) found that the percent germination rates of the tomato seed treated with AC electric and magnetic fields were accelerated about 1.1–2.8 times compared with that of the untreated seeds. Bondarenko *et al.*, (1996) used a device for magnetic field treatment in field experiments in Russia and found that in vegetable seeds the germination percentage was higher and the plant growth in early stages was higher too.

The maximum vigour index-II with magnetic pre-soaking seed treatment might be due to cumulative effect of seedling dry weight and germination percentage which were greatly influenced by magnetic treatment in tomato seed at laboratory conditions. Similarly, the effect of magnetic field doses (strength and exposure time) tested in the present study are in agreement with those of other workers (Aladjajjyan, 2002; Dagoberto *et al.*, 2002; Harichand *et al.*, 2002; Martinez *et al.*, 2002, Moon & Chung, 2002).

Increase in magnetic field gives lower EC values and all electrical field treatment gave higher EC values Kubisz L. (2012). The magnetic field is believed to influence the structures of cell membranes and in this way increases their permeability and ion transport through the ion channels, which then affects various metabolic activities Waleed *et al.*, (2013).

It is concluded from the present investigation that the Pre-sowing treatment of magnetic-field with T₄-400 gauss @ 30 minutes showed maximum increase in germination ability and vigour and showed maximum increase in germination. Magnetic treatment to the tomato seeds for 15 minutes and 30 minutes, in which 400 gauss @ 30 minutes best result to enhanced germination ability, vigour and seedling characters. These conclusions are

based on the results of six months investigation and therefore further investigation is needed to arrive at valid recommendations.

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