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Influence of Magnetic and Electric Field on Germination Attributes of Chilli (*Capsicum annum* L.) Seeds

Dalavai Srikanth*, Prashant Kumar Rai, Saritha Khandka and G.B.N. Jyothi

Department Of Genetics and Plant Breeding

Sam Higginbottom University of Agriculture Technology And Sciences, Allahabad – 211007 2018

*Corresponding Author E-mail: srikanthdalavai143@gmail.com

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ABSTRACT

The study aimed to determine the effect of magnetic -electric field on the growth characteristics of chilli was set to establish baseline data for farmers on the possible utilization of Electro - Magnetic Field (EMF). The application of magnetic and electric fields appears to produce changes in some physiological and biochemical processes of plants, including encouraging their development. In this regard, our study focuses on the comparison of the effects on seeds when exposed to magnetic fields and electric fields of different intensities under laboratory conditions. Seeds are exposed to magnetic field of 250 gauss, 500gauss, 750gauss, and 1000 gauss intensities for the duration of 30 minutes and electric field of 100mA, 200mA, 300mA, and 400mA for duration of 1 minute. And also combination of both magnetic and electric field of 250 gauss+100 mA, 500 gauss+100mA, 750 gauss+100 mA, 1000 gauss+100 mA. And the research showed that high magnetic field enhances the germination capacity and seedling characteristics of seeds. Magnetic field exposure to seeds gives positive results when compared to electric field exposure.

Key words: *Magnetic field, Electric field, Germination, Physiological, Chilli seeds*

INTRODUCTION

India is the largest producer contributing for about 38% of production. Chilies have been used in Ayurvedic medicines and used as tonic to ward off many diseases and stimulate digestive system it consists of beta-carotenoids which are powerful antioxidant. These antioxidants destroy free radical bodies. Usually these radical bodies may travel in the body cause huge amounts of damage to cells and could damage nerve and blood vessel in diabetes patients. In general, synthetic inputs such as fertilizers are used to increase this crop yield, but excessive use of chemicals do pose a potential risk to humans and side effects to the environment. So there is a need to use new technologies to increase food production. These physical factors often only modify the course of some physiological processes in the seeds, which increases their vigour and contributes to the improved development of the plant.

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Special attention should be paid to the electromagnetic fields which can stimulate some processes occurring in the seeds and plants. In recent years, several studies have been accomplished by researchers to evaluate the effects of electric and magnetic fields on the viability of plants and biological commodities. Enhancement of seed vigor and germination of different species by treating seeds with magnetic or electromagnetic fields has been confirmed by many scientists. The literature indicates that magnetic and electrically treated seeds results in better germination percentage, seedling growth, shoot length, and root length compared with non-exposed seeds. These studied here to explore its behavior in the presence of static electric and magnetic fields.

Florez *et al.*[12] reported that the germination and early growth of maize seedlings were enhanced when seeds were exposed to a stationary magnetic field[1]. Growth of germinated Viciafaba seedlings was enhanced by the application of power frequency magnetic fields (100 T), supported by an increased mitotic index and 3H-thymidine uptake[2]. Likholat *et al.*[22] asserted that the influence of alternating magnetic field with the frequency of 30–35 Hz and maximum amplitude of about 30 mT on pea, sunflower and wheat seeds imbibing in water improved their germinating[3]. Sirotina *et al.*[25] observed an enhanced formation of lateral roots in millet after seed treatment with a weak pulsating field (50 Hz) with the intensity of 8 A/m[4]. Hitherto, little work has been reported on investigation of effects of different duration of electric field on plant seed[5]. The objectives of the present research is to find the level of magnetic and electric field which stimulates bitter chilli seeds, to explore the effect of magnetic and electric field treatments on seedling characteristics of chilli seeds.

MATERIAL AND METHODS

Seeds of chilli(*capsicum annum* L.) G-4 variety of healthy and uniform size were selected and used to study effects of magnetic and electric fields on germination attributes.

Method for Magnetic Field

To treat the seeds electromagnetic field generator "OMEGA EMU-10" with variable horizontal magnetic strength with a gap of 5cm between pole pieces was fabricated. . Magnetic field flows through the cylinders when we input the power supply. A DC power supply 230 AC (0-4 Amp) (±10% AC 50HZ) with continuously variable output current was used for the electromagnet. A digital gauss meter OMEGA DGM-20 (230V AC ±10% at 50HZ) was used to monitor the field strength produced in the pole gap of magnetic field generator. The metallic probe made of indium arsenide crystal and encapsulated to a non-magnetic sheet is used. This could measure in steps of the magnetic field. And the seeds were treated with 250 gauss, 500 gauss, 750 gauss, and 1000gauss for duration of 30 minutes.

Method for Electric Field

To expose the seeds to electric field, an electric field generator was fabricated by using sodium chloride as electrolyte with copper (+) and zinc (-) electrodes. A battery of 24V DC was used as the power source for the electrolytic treatment of chilli seeds. The two electrodes were placed vertically inside the plastic tray parallel to each other. In the plastic tray seed material were placed in already prepared electrolyte solution (2% Nacl) in such a way that upper level of electrolyte solution lies below the level of electric cord connecting point. Electric power cords were connected with power supply unit in respective places. An electric current of DC 24 V was passed at required intensities for different duration as per the treatment requirement through the seeds to serve electrotherapy treatment of 100mA, 200mA, 300mA and 400mA for duration of 1 min.

Seeds were sown in Petri plates of 4 replications of 25 seeds each under laboratory conditions. Control seeds were kept under the similar condition in the absence of EMF.

Experimental Data and Statistical Analysis

Total of 13 treatments were conducted on the basis of completely randomized design. At each treatment, the experiments were replicated 4 times and the average values were reported. The

mean, coefficient of variation and critical difference of the physiological specifications of chilli seeds were determined using WASP software program. The effects of electric field and magnetic field intensity on physiological characteristics were evaluated using analysis of variance (ONE WAY ANOVA), and mean significant differences were compared using the least significant difference test at 5% significant level.

RESULTS AND DISCUSSION

The results and statistical analysis revealed that the effect of magnetic and electric field intensities and their combination effect on seedling characters were significant.

Germination Percentage

Germination percent of seeds treated with magnetic field of 1000 gauss shows the best result of 95%. Increase in magnetic field increases the germination capacity the seeds. And germination percent of seeds treated with electric field shows best at lower intensities. Seeds pre-sowing magnetic field treatments will induce biochemical and physiological changes seed that resulting in faster water absorption and respiration as swell as intensifying of photosynthesis and germination result increases the biological capacities of seed. Florez *et al*[12] reported that exposure of maize seeds to SMF enhances the germination and early growth. It has been believed that exposing biological process, including free radicals, activities stimulation of proteins and enzymes increase seed power.

Speed of Germination

Seeds treated with magnetic field of 1000 gauss germinates early followed by 300 mA of electric field germinates earlier compared to control. Pittman *et al.* reported that speed of germination of some cereals is affected by seed orientation relative to the lines of force of the geomagnetic or an introduced magnetic field.

Seedling length

And there is improvement in Shoot length, root length, and seedling length of the seeds treated with magnetic field of 1000 gauss (T_4) followed by T_{12}-1000 gauss+100mA of magnetic and electric field combinations and 300 mA (T_7) of electrical treatment compared to control (T_0).Regarding to seedling growth, our results clear that a positive effect on testing parameters seedling length Similar results were obtained by Kubisz *et al*.[20], they observed that clear differences in the length of radicals and fresh mass of seedling, longer radicals and bigger seedling than the ones from the control on the onion seeds exposed to magnetic field Waleed *et al*.[27], showed that root length, length of radical, dry weight of root and radical increased by 18, 12, 0.52 and 43%, respectively when exposed wheat seeds to (50 mT/30 min).

Dry Weight

There is improvement in dry weight of the seeds treated with magnetic field of 1000 gauss compared to control. And seeds treated with EF do not show much response in enhancing the dry weight of the seeds.

Seed vigour

Vigour index was calculated as: Vigour I = Final germination (%) × Total seedling. &vigour II = germination % ×seedling dry wt. The results also indicate that chilli seeds which had high viability and vigour respond better at high magnetic field of 1000 gauss followed by combination treatment of 1000 gauss MF and 100mA EF. This improvement in vigour of cilli seeds could be attributed to stimulation of biochemical processes which affect activities of various metabolic pathways such as protein formation and activation of enzymes.

Electrical Conductivity

To determine the membrane damage the electrical conductivity test was conducted. Fifty seeds from each treatment were replicated four times and soaked indeionized water for 24 hr. electrical conductivity of the leachates was measured with the help of digital conductivity meter. Results show that T_4-1000 gauss has lower EC values. Increase in magnetic field gives lower EC values and all electrical field treatment gave higher EC values. 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. T+he increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for overall increase in seedling length, seedling dry weight and vigour indices.

Table 1: Analysis of Variance for over all Treatments Evaluated in Chilli Seeds

+	Germination %	Shoot length	Root length	Seedling length	Vigour index-I	Vigour index-II	Speed of germination	Dry weight	EC
Treatments	23.744	0.903	3.222	6.676	73688.4	10.282	0.398	0.002	0.049
Error	7.487	0.022	0.073	0.106	181.24	0.062	0.073	0.001	0.073
CD @ 5%	3.914	0.210	0.385	0.466	7.256	0.357	0.388	0.004	0.003

* Significant at 5% level of significance, respective

Table 2: Mean performance of chilli for seedling characteristics

Treatments	Germination %	Root length	Shoot length	Seedling length	Speed of Germination	Dry weight	Vigour index-I	Vigour index-II	EC
Control	86.00	5.81	3.27	9.09	4.93	0.03	781.39	2.39	0.45
T1	89.00	5.10	3.28	8.37	4.55	0.03	744.42	2.94	0.44
T2	90.00	5.93	3.33	9.26	5.26	0.04	833.32	3.56	0.44
T3	91.00	6.12	3.59	9.71	5.45	0.02	882.67	2.26	0.43
T4	95.00	8.72	4.39	13.11	5.67	0.08	1244.94	7.41	0.42
T5	91.00	6.01	3.13	9.14	5.13	0.03	831.01	2.55	0.58
T6	87.00	6.41	3.25	9.65	5.12	0.03	839.51	2.79	0.60
T7	89.00	6.67	3.36	10.03	5.36	0.04	902.83	2.90	0.63
T8	88.00	6.32	2.80	9.12	5.03	0.03	801.97	2.48	0.66
T9	90.00	5.31	2.70	8.01	4.78	0.04	721.18	3.38	0.73
T10	90.00	5.53	2.51	8.03	5.28	0.04	722.84	3.78	0.68
T11	86.00	6.35	2.81	9.16	5.31	0.04	787.76	3.66	0.66
T12	91.00	6.75	3.43	10.17	5.59	0.07	925.84	6.60	0.64
Mean	89.46	6.23	3.22	9.45	5.19	0.04	847.67	3.59	0.57
S.Em	1.368	0.135	0.074	0.163	0.136	0.001	6.731	0.125	0.001
CV	3.059	4.323	4.573	3.447	5.223	6.359	1.588	6.948	0.366
CD (5%)	3.914	0.385	0.210	0.466	0.388	0.004	7.256	0.357	0.003

CONCLUSION

The present study concluded that magnetic field treatment to chilli seeds given best results compared to electric and combination treatments. Among various treatments T_4 - 1000 Gauss for 30 minutes exposure of seed to magnetic field gave best results. It followed by combination seed treatment $T_{1\ 2}$ -1000Gauss for 30 minutes+100Ma electric field for 1 minute, and T_7-300 mA for 1miute exposure given best results. And the research showed that high magnetic field enhances the germination capacity and seedling growth and vigour of seeds. Magnetic field exposure to seeds gives more positive results when compared to electric field exposure.

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