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RESEARCH PAPER

Effect of electrostatic field on enhancing seed quality parameters of chilli (*Capsicum annum* L.)

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Abstract: Chilli (*Capsicum annum*), a vital spice and vegetable crop in Indian cuisine, offers numerous health benefits hidden in its seeds. However, seed quality often suffers due to harsh post-harvest handling and storage. To mitigate these losses, seed enhancement techniques are employed, with physical seed treatment being particularly favoured for its cost-effectiveness, ease of use, and environmental safety. This paper presents an experiment conducted in 2023 at the Department of Seed Science and Technology, College of Agriculture, UAS, Dharwad, Karnataka. Chilli *cv* (Rudra) seeds with a minimum germination standard of 60% and medium to low vigor were subjected to pre-sowing electrostatic field treatment at five different power capacities and two exposure durations, along with an untreated control group. The results showed a steady increase in seed germination with higher power capacities, peaking at 91% germination at 5 kV for 90 seconds, compared to an initial 63%. Seedling vigor indices, mean seedling length, and seedling dry weight were all highest at 5 kV for 90 seconds. All parameters showed improvement with increased power capacity compared to untreated seeds. Additionally, the percentage of diseased and abnormal seeds decreased with higher power treatments. The most effective treatment was found to be 5 kV for 60 to 90 seconds, improving seed germination by 31%, making the seeds more cost-effective and reliable

Key words: Chilli, Electrostatic field, Germination**,** Pre-sowing, Seed treatment

Introduction

India is the world's largest producer, consumer and exporter of chilli. Quality seed is the key for successful agriculture, which demands every seed should be readily germinable and produce a vigorous seedling, ensuring high yield.

Seed quality often suffers due to harsh post-harvest handling and storage. To mitigate these losses, seed enhancement techniques are employed, with physical seed treatment being particularly favoured for its cost-effectiveness, ease of use, and environmental safety. Electrostatic field seed treatment can potentially enhance the germination of medium to low vigour seeds. Since low vigour seeds often fail to meet Indian minimum seed certification standards, this method offers an effective solution to improve germination rates. Hence the present investigation is to evaluate the effect of electrostatic field seed treatment on physiological parameters in chilli seeds.

Material and methods

The present study entitled "Effect of electrostatic field on seed quality of chilli (*Capsicum annum* L.)" was carried out at the Department of Seed Science and Technology, University of Agriculture Sciences, Dharwad, Karnataka during 2023 - 24.

The chilli cultivar Rudra was obtained from the Seed Unit. Rudra is a *kharif* chilli variety suitable for cultivation under both rainfed and irrigated conditions. It features an upright growth habit and exhibits a purple colour due to its high anthocyanin content. With an oleoresin percentage ranging from 16 to 17.5%, Rudra produces dark-coloured red ripened fruits that develop prominent wrinkles upon drying. Its dry chilli pungency (SHU) is relatively low at 9833. Cleaned and dried seeds were used for estimating initial seed quality parameters and biochemical parameters. 10-12 gram seeds were placed between 2 metal plates and electrostatic field was given to them with varying time period. The below mentioned treatments were performed at Department of agriculture engineering, Mahatma Phule Krishi Vidyapeeth MPKV), Rahuri, Maharashtra.

At a constant Frequency of 50 Hz, 11 treatments were carried out where T_1: Control, T_2: 1kV cm^{-1} for 60 sec, T_3: 1kV cm^{-1} for 90 sec, T_4: 2kV cm^{-1} for 60 sec, T_5: 2kV cm^{-1} for 90 sec, T_6: 3kV cm^{-1} for 60 sec T_7: 3kV cm^{-1} for 90 sec, T_8: 4kV cm^{-1} for 60 sec, T_9: 4kV cm^{-1} for 90 sec, T_{10}: 5kV cm^{-1} for 60 sec, T_{11}: 5kV cm^{-1} for 90 sec.

Results and discussion

In seeds treated with an electrostatic field, various seed quality parameters, such as seed germination (%), seedling root length (cm), seedling shoot length (cm), seedling vigor indices I and II, seedling dry weight (mg/10 seedlings), and seedling fresh weight (mg/10 seedlings), showed improvement with increased intensity and duration of exposure. Similar results were observed in a study on maize by Boniche *et al.* (2017). The highest improvements were recorded with the 5kV cm^{-1} treatment for 90 seconds, which achieved a germination rate of 90.25%, root length of 9.2 cm, shoot length of 10.13 cm, fresh weight of 56.23 mg, dry weight of 39.75 mg, vigor index I of 1637, and vigor index II of 3319. These findings align with the results of Molamofrad *et al*. (2013) in their work on onions.

Table 1. Effect of electrostatic field treatment on seed germination percentage, abnormal see

Treatment	Germination (%)	Abnormal seedlings	Speed of germination
T_1: Control.	62.75(52.36)**	6.50	19.88
T_2: 1kV cm^{-1} for 60 sec	68.25(55.68)	5.75	20.60
T_3: 1kV cm^{-1} for 90 sec.	72.05(58.06)	5.00	20.9
T_4: 2kV cm^{-1} for 60 sec.	72.00(58.02)	5.75	21.25
T_5: 2kV cm^{-1} for 90 sec.	75.75(60.47)	4.25	21.65
T_6: 3kV cm^{-1} for 60 sec.	75.75(60.47)	3.25	22.20
T_7: 3kV cm^{-1} for 90 sec.	78.00(68.00)	2.25	22.40
T_8: 4kV cm^{-1} for 60 sec.	79.00(61.37)	2.25	22.58
T_9: 4kV cm^{-1} for 90 sec.	83.75(61.83)	2.50	23.45
T_{10}: 5kV cm^{-1} for 60 sec.	85.50(67.59)	1.00	23.83
T_{11}: 5kV cm^{-1} for 90 sec.	90.25(71.77)	0.50	24.15
Mean	76.64(61.07)	3.71	22.08
S.Em.±	1.336	0.538	0.196
C.D. at 1%	5.163	2.081	0.758

** arc sine transformed values

Table 2. Effect of electrostatic field treatment on seedling root length, shoot length, root to shoot ratio and seedling vigor index I in chilli (cv. Rudra)

Treatment	Root length (cm)	Shoot length (cm)	Root shoot ratio	Seedling vigor index - I
T_1: Control.	6.20	5.55	1.12	738
T_2: 1kV cm^{-1} for 60 sec	6.58	5.60	1.19	831
T_3: 1kV cm^{-1} for 90 sec.	6.73	5.63	1.19	899
T_4: 2kV cm^{-1} for 60 sec.	6.95	6.85	1.01	943
T_5: 2kV cm^{-1} for 90 sec.	7.10	7.05	1.00	1071
T_6: 3kV cm^{-1} for 60 sec.	7.70	7.75	1.00	1150
T_7: 3kV cm^{-1} for 90 sec.	7.93	8.33	0.95	1263
T_8: 4kV cm^{-1} for 60 sec.	8.25	8.40	0.98	1299
T_9: 4kV cm^{-1} for 90 sec.	8.35	9.03	0.92	1351
T_{10}: 5kV cm^{-1} for 60 sec.	9.15	9.65	0.94	1560
T_{11}: 5kV cm^{-1} for 90 sec.	9.20	10.13	0.90	1637
Mean	7.65	7.63	1.02	1158
S.Em.±	0.109	0.15	0.043	21.205
C.D. at 1%	0.422	0.581	0.173	81.966

Electrostatic treatment is believed to enhance seed vigor by influencing biochemical processes, including free radical activity, and by stimulating protein and enzyme activity (Morar *et al.,* 1999). When seeds are exposed to an electrostatic field, an interaction occurs between the seed dipoles and the water dipoles formed by the field. This interaction improves water uptake by the seeds, leading to reduced germination time and increased germination rates (Mahajan and Pandey, 2014). The partial discharges between seeds during electrostatic treatment generate ozone, which activates hydroxy radicals that intensify biological processes. Additionally, corona discharges due to the electric field impact the biological activity of seeds (Lynikiene *et al.,* 2006).

Table 3. Effect of electrostatic field treatment on seedling fresh weight, seedling dry weight & seedling vigor index-II in chilli (cv. Rudra)

Treatment	Seedling fresh weight (mg/ 10 seedlings)	Seedling dry weight (mg/ 10 seedlings)	Seedling vigor index II
T_1: Control.	41.67	20.60	1295
T_2: 1kV cm^{-1} for 60 sec	41.70	24.38	1666
T_3: 1kV cm^{-1} for 90 sec.	41.73	28.25	2056
T_4: 2kV cm^{-1} for 60 sec.	45.03	28.90	2025
T_5: 2kV cm^{-1} for 90 sec.	42.60	29.53	2236
T_6: 3kV cm^{-1} for 60 sec.	46.03	33.10	2478
T_7: 3kV cm^{-1} for 90 sec.	47.73	36.15	2822
T_8: 4kV cm^{-1} for 60 sec.	50.10	36.70	2825
T_9: 4kV cm^{-1} for 90 sec.	52.83	37.83	2942
T_{10}: 5kV cm^{-1} for 60 sec.	53.33	38.23	3172
T_{11}: 5kV cm^{-1} for 90 sec.	56.23	39.75	3319
Mean	55.95	32.13	2439
S.Em.±	0.231	0.73	69.875
C.D. at 1%	0.922	2.823	270.096

Studies have shown that seeds treated with an electric field exhibit lower leachate rates, indicating higher cellular membrane integrity. These seeds also demonstrate a higher mitotic index and greater incorporation of H-thymidine into DNA. The associated resonance disrupts the sequestration of Ca^{2+} ions, increasing the concentration of free Ca^{2+}, which accelerates the mitotic cycle and enhances repair. These findings align with Afrasiyab *et al.* (2020) in their study on chickpeas. The improvement in field parameters is attributed to enhanced physiological activity from increased moisture absorption by treated seeds, as seen in studies on oak trees which reported increases in main stem height, dry weight, and germination rate (De Souza *et al.,* 2006). The accelerated rate of biochemical changes may lead to higher production of growth-activating substances like auxins and glutathione (Jakubowski, 2008). Additionally, a resonance-like phenomenon might boost the internal energy of the seeds when the electrostatic field and exposure time are optimally combined, resulting in vigorous seedling growth (Vashisth and Joshi, 2017).

Conclusion

Electrostatic field treatments with 5kV cm^{-1} for 90 seconds and 60 seconds recorded the higher parameters amongst other treatments. Electrostatic field seed treatment has emerged as a promising method for enhancing seed quality and improving overall crop performance. Additionally, these method shows long-term effectiveness, maintaining better seed quality even. Given its efficiency, cost-effectiveness, and suitability for organic farming, electrostatic field seed treatment represents a valuable tool for modern agriculture, promoting healthier and more robust crop yields.

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