



Effect Of Magnetic Field On Germination And Seedling Growth Of Cumin

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Abstract: An experiment was conducted during four years of 2018 to 2022 under laboratory conditions at College of Agricultural Information Technology, Anand Agricultural University, Anand, Gujarat to study the effect of magnetic field on germination and seedlings growth of cumin. Cumin seeds were exposed with three levels of static magnetic field intensities of 100, 200 and 300 mT having 15, 30 and 45 minutes of exposure time. Cumin variety “Gujarat Cumin 4 (GC 4)” was taken for this experiment. From the experimental results, it was found that the exposure of magnetic field increased the germination percentage, seedling fresh and dry weight, root and shoot length as well as seedling vigour as compared to no exposure. However, exposure of 300 mT magnetic field applied to the cumin seeds for 45 minutes was recorded significantly higher germination percentage, seedling fresh weight, dry weight, root and shoot length and seedling vigour index I and vigour index II.

Key words – Static Magnetic field, germination percentage, seedling vigour index I and II.

INTRODUCTION

Exposure of magnetic field to the seed is one of the physical pre-sowing seed treatments reported by many scientists to improve the performance of crops. In modern agriculture, efforts are being made to search for an efficient eco-friendly production technology based on physical treatment of seeds for increasing seedling vigour and crop establishment. Seed exposure by magnetic field is one of the potential, safe, and affordable physical pre-sowing treatments for enhancing germination, plant development, and crop stand.

Cumin is an annual herbaceous plant belonging to family *umbelliferae* of dicotyledonous group. It is native to Egypt and the Mediterranean region. The demand for cumin is fairly increasing in the domestic as well in international market which plays an important role in national economy. While the production and productivity of cumin is decreasing year after year due to several reasons viz., unavailability of good quality seeds, slow and uneven germination, low adoption of seed production technologies, degradation of seed quality due to microbial load, heavy infestation of diseases and pests, traditional harvesting & processing, unscientific and unhygienic handling at post-harvest and storage are the major problems in realizing the production potential of cumin. Poor physical purity and seed germination directly affects the establishment of plant population and causing diseases in the field conditions leading to poor seed yield in cumin (Trivedi, 2017). Hence, seed treatment is one of the methods adopted for quality seed production as it not only reduces the deleterious effects of damage to seed viability and vigour but also provides better avenues for their establishment, growth and development of seedlings. Therefore, this study was to investigate the effect of exposure to static uniform magnetic fields on seed germination and seedling growth of cumin seeds.

RESEARCH METHODOLOGY

The experiment was conducted during the years of 2018 to 2022 at the Department of Agricultural Sciences, College of Agricultural Information Technology, Anand Agricultural University, Anand, Gujarat to study the effect of magnetic field on germination and seedling growth of cumin. “Gujarat Cumin 4 (GC 4)” variety of cumin crop was used in the experiment. Treatment combinations of magnetic field exposure with different time interval were taken for cumin seeds viz. T₀: No magnetic field (Control), T₁: 100 mT Magnetic field given to seed for 15 min., T₂: 100 mT Magnetic field given to seed for 30 min., T₃: 100 mT Magnetic field given to seed for 45 min., T₄: 200 mT Magnetic field given to seed for 15 min., T₅: 200 mT Magnetic field given to seed for 30 min., T₆: 200 mT Magnetic field given to seed for 45 min., T₇: 300 mT Magnetic field given to seed for 15 min., T₈: 300 mT Magnetic field given to seed for 30 min., T₉: 300 mT Magnetic field given to seed for 45 min. The experimental data was analyzed with Completely Randomized Design repeated in thrice. Magnetic field treated seeds were stored up to 10 days period as a means of transportation period from lab to land conditions for sowing. After that, the seeds were put for germination in a seed testing laboratory of Department of Seed Science and Technology, Anand Agricultural University, Anand by blotting paper method in fully automated germinator. During the experimental period in the year 2019, due to fungal infestation in seeds the experiment was vitiated. So, only three years data were considered for the statistical analysis.

Magnetic field generation

An electromagnet EMU-50 with variable horizontal magnetic field generated with most widely used soft iron yoke having capacity to generate magnetic field strength up to 7.5 kG at 10 mm air-gap with flat pole pieces as utilized for generation of electromagnetic field. The air gap between pole pieces can be varied with two way knob-bed wheel screw adjusting system. The cylindrical shaped pole pieces were made from dead annealed soft iron blocks of the best quality. The resistance of the two energizing coil was about 3 Ohms each. A DC regulated power supply (0-30 V/4 A) with continuously variable output current was used for the electromagnet. A digital Gauss meter model DPS - 50 of SES Instruments Pvt. Ltd. Roorkee was used. The probe made of Indium Arsenic crystal and encapsulated to a non-magnetic cylindrical cover was used to measure magnetic field strength (Vashisth and Nagarajan, 2010).

Magnetic treatment

Cumin seeds were exposed to the magnetic field of 100 – 300 mT for 15, 30 and 45 minutes respectively, for all field strengths in a small plastic bag, made up of a non-magnetic thin transparent polyethylene plastic sheet (Fig. 1). A sample of 100 visibly sound, mature, healthy seeds was held in the plastic bag at a volume between the poles of the electromagnet having a uniform magnetic field for the required duration. The required strength of the magnetic field was obtained by regulating the current in the coils of the electromagnet. A Gauss meter was used to measure the strength of the magnetic field between the poles. For 160 mT from poles to center, the variation was 0.4% in the horizontal direction and 0.8% in the vertical direction of the applied field. The local geomagnetic field was less than 10 mT. All treatments in the experiments were run simultaneously along with controls under similar condition.

Different seed germination observations were observed by following the standards as per ISTA (1985). Three repetitions of each treatment with 25 seeds were placed in petridish with a layer of moist germination paper and covered to reduce surface evaporation. They were placed in the germination incubator at 20 °C for standard days to germination test required moisture condition. Germination percentage was calculated based on normal seedlings growth. Ten such seedlings from each replicate were randomly taken for measuring shoot and root length in cm. Subsequently, they were dried overnight in an oven at 90 °C and the dry weight of these seedlings was measured. Seedling vigour was calculated following Abdul-Baki and Anderson (1973) as follows

$$\text{Seedling Vigour Index} - I = \text{Germination \%} \times \text{Seedling length}$$

$$\text{Seedling Vigour Index} - I = \text{Germination \%} \times \text{Seedling dry weight}$$

RESULTS AND DISCUSSION

The results shown in Table 1 on effect of exposure of magnetic field to cumin seed at different levels on germination and seedling fresh and dry weight were found significant results. Germination percentage of cumin recorded significantly higher under T₂ (100 mT magnetic field exposure for 30 min) and T₉ (300 mT magnetic field exposure for 60 min) which were at par with treatments T₇, T₁ and T₆ during 2018 while T₄, T₉, and T₈ during 2020. The seedling fresh weight was recorded significantly higher under treatment T₆ (200 mT magnetic field exposure for 60 min) which was at par with treatment T₇ and T₉ during 2018 while T₄ was recorded significantly higher seedling fresh weight than others except T₅, T₆, T₂ and T₉. However, significantly the highest seedling fresh weight was recorded under treatment T₉ during the year 2021. Significantly higher seedling dry weight of cumin was recorded under treatment T₉, T₄ and T₆, respectively during the individual years which were at par with treatments T₆ and T₇ in 2018, T₂, T₆ and T₉ in 2020 and T₉, respectively. In pooled analysis, seedling fresh weight and dry weight were observed significantly higher under T₉ paring with treatments T₄, T₅, T₆ and T₇.

The data presented in Table 2 influenced significantly due to magnetic field on seedling root, shoot and seedling length. Exposure of 200 mT magnetic field for 30 minutes during the year 2018 while 45 minutes during the years 2020 and 2021 were observed significantly higher seedling root length which was at par with T₂ and T₇ during 2018, while during the years 2020 and 2021 the most of the treatments were on par with treatment T₆. Seedling shoot length was recorded significantly higher under treatment T₁ paring with T₂ during the year 2018, treatment T₃ and T₉ were recorded significantly higher shoot length than others during the years 2020 and 2021. Similarly seedling length was recorded significantly higher under treatment T₅ during the year 2018 on paring with T₂ and T₇ while treatment T₃ and T₆ were significantly higher seedling length were recorded during the years 2020 and 2021 as compared to others which was at par with most of the treatments. However, pooled results of root length, shoot length and seedling length was not affected due to magnetic field treatments.

Seedling vigour was significantly influence due to exposure of magnetic field was presented in Table 3. Significantly the highest Seedling Vigour Index – I was recorded under treatment T₂ during the year 2018 while treatment T₂ observed significantly higher Seedling Vigour Index – I than others but it was at par with treatments T₃, T₄, T₈ and T₉ during the year 2020. Treatment T₆ and T₉ were recorded significantly higher Seedling Vigour Index – I during the year 2021 were on par with treatments T₅, T₇ and T₈. Seedling Vigour Index – II was reported significantly higher under treatment T₉ during the year 2018, treatment T₄ during the year 2020 and treatment T₆ during the year 2021 as compared to others which was at par with treatment T₇ during 2018, treatment T₂ during 2020 and treatments T₅ and T₉ during 2021. However, pooled over the treatments recorded non significant results on Seedling Vigour Index – I while Seedling Vigour Index – II was recorded significantly higher under treatment T₉ which was at par with treatments T₄, T₅, T₆ and T₇ in pooled results. Samani *et al.* (2013) also reported that exposure of cumin seeds to different magnetic field intensities increased the germination, shoot length, root length, total seedling length, fresh and dry weight of seedling as well as seedling vigour indices. They also observed that magnetic field treated cumin seeds increased their enzymatic activities which results faster germination and seedling vigour. Magnetic field exposure on chickpea seeds gave positive response noted by Vashisth and Nagarajan (2008). Kavi (1977) also reported significant response of magnetic field on soybean crop to increased capacity to absorb moisture. Amin *et al.* (2024) also reported the significant effect of magnetic field on onion seeds. Increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for increase in seedling length, seedling dry weight, and vigor indices.

CONCLUSION

Exposure of static magnetic field to cumin seeds increased germination, seedling root, shoot and seedling length, fresh and dry weights of seedling and vigour indices significantly compared to no magnetic field treated seeds (control). Among the various treatments of magnetic field, exposure of 300 mT magnetic field for 45 minutes gave significant and consistent results over other treatments. Cumin seeds exposed to this treatment showed significantly increased germination percentage, seedling root length, shoot length, seedling length, fresh weight, dry weight of seedling as well as seedling vigour indices as compared to control.

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Table 1 Effect of magnetic field on germination and seedling fresh and dry weight of cumin

Treatments	Germination %				Seedling fresh wt. (mg)				Seedling dry wt. (mg)			
	2018	2020	2021	Pooled	2018	2020	2021	Pooled	2018	2020	2021	Pooled
T ₀	83.67	62.00	81.33	75.67	34.57	42.50	60.30	45.79	4.67	4.00	8.93	5.87
T ₁	94.33	69.00	86.67	83.33	58.80	61.17	69.00	62.99	7.37	4.23	9.53	7.04
T ₂	98.33	79.00	86.67	88.00	55.97	71.07	73.33	66.79	6.18	5.77	8.50	6.82
T ₃	86.33	67.33	85.33	79.67	50.13	59.20	75.30	61.54	7.92	4.20	9.03	7.05
T ₄	86.00	77.33	81.33	81.56	73.24	74.83	73.33	73.80	8.03	6.07	9.33	7.81
T ₅	89.67	63.33	96.00	83.00	89.57	71.67	76.67	79.30	8.32	4.80	9.77	7.63
T ₆	92.33	65.33	94.67	84.11	99.36	71.21	90.00	86.86	8.58	5.47	10.83	8.29
T ₇	96.33	72.00	93.33	87.22	98.21	57.90	80.00	78.70	9.02	4.50	9.27	7.59
T ₈	85.67	73.67	92.00	83.78	56.35	60.00	84.20	66.85	6.42	4.33	9.10	6.62
T ₉	98.33	74.33	96.00	89.56	96.00	68.33	100.00	88.11	9.53	5.60	10.70	8.61
S.Em. ±	2.11	1.90	3.13	2.83	3.08	2.55	2.61	6.55	0.35	0.21	0.29	0.47
	Y x T			2.44	Y x T			2.76	Y x T			0.29
C. D. (P = 0.05)	6.24	5.60	9.23	NS	9.10	7.53	7.69	19.47	1.03	0.62	0.85	1.38
	Y x T			6.90	Y x T			7.80	Y x T			0.81
C. V. (%)	4.02	4.67	6.06	5.05	7.50	6.93	5.77	6.72	7.97	7.38	5.25	6.8

Table 2 Effect of magnetic field on seedling root length, shoot length and seedling length of cumin

Treatments	Root length (cm)				Shoot length (cm)				Seedling length (cm)			
	2018	2020	2021	Pooled	2018	2020	2021	Pooled	2018	2020	2021	Pooled
T ₀	2.85	1.17	2.32	2.11	1.33	1.74	1.67	1.58	4.18	2.90	3.99	3.69
T ₁	3.93	1.31	2.55	2.60	2.45	1.91	1.87	2.08	6.38	3.22	4.42	4.67
T ₂	4.97	1.46	2.65	3.03	2.31	2.22	1.91	2.15	7.28	3.68	4.56	5.17
T ₃	3.69	1.45	2.83	2.66	1.94	2.44	2.04	2.14	5.63	3.89	4.87	4.80
T ₄	4.03	1.37	1.78	2.39	1.68	2.23	2.09	2.00	5.71	3.60	3.87	4.39
T ₅	5.20	1.24	2.80	3.08	2.09	2.06	2.05	2.07	7.29	3.30	4.85	5.15
T ₆	4.07	1.47	3.02	2.85	2.08	2.25	2.10	2.14	6.15	3.71	5.12	4.99
T ₇	4.74	1.36	2.81	2.97	2.07	1.76	2.10	1.97	6.81	3.12	4.91	4.94
T ₈	2.40	1.44	2.83	2.22	1.09	2.21	1.93	1.74	3.49	3.65	4.75	3.96
T ₉	3.36	1.45	2.89	2.57	1.63	2.22	2.17	2.01	4.99	3.67	5.06	4.58
S.Em. $\pm$	0.16	0.06	0.09	0.32	0.07	0.08	0.09	0.16	0.18	0.12	0.13	0.44
	Y x T			0.11	Y x T			0.08	Y x T			0.15
C. D. (P = 0.05)	0.46	0.18	0.28	NS	0.21	0.24	0.25	NS	0.52	0.35	0.39	NS
	Y x T			0.31	Y x T			0.22	Y x T			0.41
C. V. (%)	6.83	7.79	6.18	7.23	6.63	6.56	7.43	6.89	5.32	5.96	4.95	5.43

Table 3 Effect of magnetic field on Seedling Vigour Index – I and II of cumin

Treatments	Seedling Vigour Index - I				Seedling Vigour Index - II			
	2018	2020	2021	Pooled	2018	2020	2021	Pooled
T ₀	350	180	325	285	390	248	728	455
T ₁	602	222	384	403	695	292	830	605
T ₂	715	291	395	467	607	456	736	600
T ₃	486	263	416	388	683	282	770	578
T ₄	490	278	315	361	691	468	758	639
T ₅	654	209	466	443	745	304	937	662
T ₆	568	243	486	432	793	357	1027	726
T ₇	656	224	459	447	869	324	864	686
T ₈	298	269	437	335	555	319	838	571
T ₉	490	273	486	417	938	416	1026	793
S.Em. $\pm$	19.31	11.60	23.50	47.65	38.06	17.04	42.03	53.05
	Y x T			18.79	Y x T			34.18
C. D. (P = 0.05)	56.96	34.22	69.33	NS	112.29	50.25	123.98	158
	Y x T			53.16	Y x T			96.68
C. V. (%)	6.30	8.19	9.76	8.19	9.46	8.51	8.55	9.37



Fig. 1: Electromagnetic field generator with variable magnetic field strength



T₀: No Magnetic Field (Control)



T₉: 300 mT magnetic field for 45 minutes

Fig. 2: Effect of magnetic field exposure on cumin seeds