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Study of Essential Growth Parameters of Onion and Cumin seeds Exposed with a Magnetic Field

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Abstract: *This comparative study investigates the effects of uniform magnetic field exposure on the germination and seedling growth of onion (Allium cepa L.) and cumin (Cuminum cyminum L.). Magnetic treatment has become a promising eco-friendly pre-sowing technique aimed at improving seed vigor and plant growth. Onion and cumin seeds were subjected to static magnetic fields of varying intensities and exposure times. The results show that both crops responded positively, but the degree of improvement varied. The optimal magnetic exposure resulted in higher germination percentages, roots and shoots length, fresh and dry seedling weights, and increased seedling vigor indices compared to untreated seeds. While onion responded best to a 20 mT field for 60 minutes, cumin showed the highest performance under a 300 mT field for 45 minutes*

Keywords: Magnetic field, Onion, Cumin, Germination, Seedling Vigor Index, Plant Growth

I. INTRODUCTION

Magnetic field exposure has emerged as an innovative seed treatment method to enhance germination and seedling growth. As sustainable agriculture gains importance, non-chemical methods such as magnetic treatment are being explored. Onion, a widely cultivated vegetable crop, and cumin, a critical spice crop, suffer from challenges like low germination rates and reduced seed viability over time. This study seeks to compare the growth performance of onion and cumin under similar magnetic field exposure conditions, contributing to the understanding of how static magnetic fields affect different crop types.

II. RESEARCH METHODOLOGY

The experiments for onion and cumin were conducted separately at Anand Agricultural University, Gujarat, under controlled laboratory conditions. Both studies applied electromagnetic fields using the EMU-50 apparatus with soft iron yokes to generate static magnetic fields.

III. MAGNETIC FIELD GENERATION

An electromagnet EMU-50 of SES Instruments Pvt. Ltd. Roorkee with variable horizontal magnetic field generated with most widely used soft iron yoke having capacity to generate magnetic field strength upto 7.5 kG at 10 mm air-gap with flat pole pieces as utilized for generation of electromagnetic field (Fig. 1). 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).

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MAGNETIC TREATMENT

Onion:
Variety: GAWO 2
Field Strength: 20, 40, and 60 mT
Exposure Time: 15, 30, and 60 minutes

Cumin:
Variety: Gujarat Cumin 4 (GC 4)
Field Strength: 100, 200, and 300 mT
Exposure Time: 15, 30, and 45 minutes

For both crops, the treated seeds were stored briefly to simulate transport conditions and were later germinated under identical conditions using the blotting paper method in automated germinators. Observations focused on germination rate, shoot and root lengths, seedling fresh and dry weight, and seedling vigor indices.

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 ^{0}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 ^{0}C and the dry weight of these seedlings was measured. Seedling vigour was calculated following Abdul-Baki and Anderson (1973) as follows

Seedling Vigour Index – I = Germination % x Seedling length Seedling Vigour Index – I = Germination % x Seedling dry weight

IV. RESULTS AND DISCUSSION

Data presented in Table 1 on exposure of magnetic field to onion seed at different interval on germination, root and shoot as well as seedling length were found giving significant results. Exposure of 20 mT magnetic field given to the onion seed for 60 minutes (T3) recorded significantly higher germination percentage than all treatments except treatments T5 during the year 2018 while T5 and T6 during the year 2019 which were at par with treatment T3. Onion seeds were stimulated with magnetic field also reported by Pietruszewski, 2002.Seeds treated with Magnetic field germinate faster and vigorously may be stimulating the enzymatic activities accelerate their metabolism with magnetic field. Root length, shoot length and seedling length were recorded significantly the highest under treatment T3 (i.e. seed treated with 20 mT magnetic field for 60 minutes exposure) during the year 2018. While, during the year 2019 significantly higher seedling length was observed under the treatment T3 over all the treatments except treatment T4 (40 mT magnetic field exposure given to the seeds for 15 minutes) which was at par with treatment T3. Onion seeds exposed to a weak electromagnetic field for 12 h also showed significantly increased germination as well as shoot and root length of seedlings (Alexander and Doijode, 1995). The results shown in Table 2 revealed that the magnetic field exposure and time duration significantly affect on seedling length and seedling indices of onion seeds. Significantly the highest seedling fresh weight was recorded under the treatment T3 during the year 2018 while treatment T3 observed significantly higher seedling fresh weight over all treatments except treatments T4 and T9 during the year 2019. Significantly increased seedling dry weight of onion was observed under magnetic field exposure treatments as compared to control during both the years. Significantly the highest Seedling Vigour Index – I and Seedling Vigour Index – II were recorded with exposure of 20 mT magnetic field given to the seeds for 15 minutes (T3) during both the years. Exposure of magnetic field on chickpea seeds gave positive response noted by Vashisth and Nagarajan (2008). Kavi (1977) also reported that soybean seeds exposed to magnetic field had increased capacity to absorb moisture. 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.

The results shown in Table 3 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 4 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 5. 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. 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.

GERMINATION RATE

Onion seeds treated with a 20 mT field for 60 minutes exhibited the highest germination rate 83%. In contrast, cumin seeds showed superior germination under a 300 mT field for 45 minutes 96% . The response of cumin to stronger magnetic fields indicates that optimal field strength varies with crop type

SEEDLING GROWTH PARAMETERS

Onion: The optimal magnetic field 20 mT for 60 minutes led to significant increases in shoot length 6.67 cm, root length
4.22 cm, and total seedling length 10.90 cm.

Cumin: The maximum performance for cumin was observed with 300 mT for 45 minutes, resulting in a total seedling length of 7.29 cm and superior root development compared to other treatments.

SEEDLING FRESH AND DRY WEIGHTS

Onion's fresh weight peaked under 20 mT exposure, while cumin recorded the highest fresh weight under 300 mT. However, cumin exhibited greater overall dry weight than onion, suggesting a better adaptation to higher magnetic field intensities.

SEEDLING VIGOR INDEX (SVI)

Both crops exhibited an increase in seedling vigor with magnetic exposure. Onion's highest SVI-I (903) was recorded with a 20 mT field for 60 minutes, while cumin achieved the highest SVI-II (1026) under a 300 mT field for 45 minutes. The varying response implies that different crops have distinct thresholds for magnetic stimulation.

V. CONCLUSION

The study demonstrates that both onion and cumin benefit from magnetic field exposure, albeit with different optimal parameters. Onion responded best to a lower magnetic field strength (20 mT) with a longer exposure time, while cumin showed better results under a stronger magnetic field (300 mT). These findings highlight the crop-specific nature of magnetic treatment and its potential as a non-invasive, eco-friendly approach to improving agricultural productivity.

REFERENCES

[1]. Abdul-Baki A. A. and Anderson, J. D. 1973. Vigour determination in soybean by multiple criteria. Crop Science, 10:31– 34.

[2]. Alexander, M. P., Doijode, S. D. Electromagnetic field, a novel tool to increases germination and seedling vigour of conserved onion (*Allium cepa* L.) and rice (*Oryza sativa* L.) seeds with low viability. Plant Genet. Resour. Newslett. 104: 1–5.

[3]. ISTA, International Rules for Seed Testing, 2004. International Seed Testing Assoc. Zurich, Switzerland.

[4]. Kavi, P. S. 1977. The effect of magnetic treatment of soybean seed on its moisture absorbing capacity. Science Culture, 43(9): 405–406.

[5]. Pietruszewski S., 2002. Influence of magnetic fields on seeds germination of selected cultivated plants (in Polish). Acta Sci. Pol., Technica Agraria, 1(1): 75–81.

[6]. Riekels, J. W., Tiessen, H. and Nonnecke, L. I. 1976. Onions, Pub. No. 486. Ontario Department of Agriculture & Food, Ontario, Canada.

[7]. Vashisth, A. and Nagarajan, S. 2008. Exposure of seeds to static magnetic field enhances germination and early growth characteristics in chickpea (*Cicer arietinum* L.). Bioelectromagnetics, 29: 571–578.

[8]. ISTA (2004). International Rules for Seed Testing. International Seed Testing Association, Zurich.

[9]. Samani, Mahid Asadi, Pourakbar, Latifeh and Azimi, Nafiseh 2013. Magnetic field effects on seed germination and activities of some enzymes in cumin. Life Science Journal, 10(1): 323–328

Table 1 Effect of magnetic field on germination, root length, shoot length and seedling length of onion

Treatments	Germination %		Root length (cm)		Shoot length (cm)		Seedling length (cm)	
	2018	2019	2018	2019	2018	2019	2018	2019
T0	62.83	59.67	2.17	2.70	4.57	5.64	6.73	8.34
T1	77.17	60.33	2.92	2.79	5.61	6.48	8.53	9.27
T2	76.00	61.00	3.18	3.05	6.03	6.08	9.21	9.13
T3	83.00	67.83	4.22	3.59	6.67	7.20	10.90	10.79
T4	71.00	57.33	2.57	3.77	5.81	6.77	8.38	10.55
T5	78.67	69.50	3.47	2.77	6.00	5.88	9.47	8.65
T6	75.17	66.33	3.45	3.19	6.59	5.90	10.03	9.10
T7	69.67	60.67	2.83	2.95	6.48	7.12	9.31	10.07
T8	74.00	59.33	2.84	3.15	5.95	6.12	8.79	9.27

T9	72.33	60.00	3.44	2.87	6.55	6.19	9.99	9.06
S.Em. ±	1.87	2.19	0.11	0.11	0.17	0.18	0.22	0.23
C. D. (P = 0.05)	5.35	6.25	0.32	0.33	0.49	0.51	0.62	0.66
C. V. (%)	6.20	8.61	8.81	9.09	7.01	6.82	5.82	6.04

Table 2 Effect of magnetic field on seedling fresh and dry weight of seedling and vigour indices of onion

Treatments	**Seedling fresh weight (mg)**		**Seedling dry weight (mg)**		**Seedling Vigour Index - I**		**Seedling Vigour Index - II**	
	2018	**2019**	**2018**	**2019**	**2018**	**2019**	**2018**	**2019**
T0	183.27	282.87	17.18	16.07	423	511	1070	1019
T1	342.00	299.17	21.12	16.80	659	579	1710	1080
T2	317.43	327.53	21.68	18.00	702	596	1704	1175
T3	398.50	381.40	22.22	20.73	903	748	1884	1457
T4	227.67	356.27	20.63	19.34	591	631	1410	1203
T5	311.50	343.20	22.97	17.10	744	617	1679	1243
T6	351.83	327.73	22.30	19.03	746	627	1603	1296
T7	255.67	343.17	20.68	19.53	648	620	1365	1227
T8	302.50	323.80	20.45	19.87	648	560	1314	1230
T9	279.57	352.70	22.27	19.77	723	552	1503	1257
S.Em. ±	9.36	11.28	0.31	0.54	24.47	28.32	52.61	52.52
C. D. (P = 0.05)	26.75	32.23	0.89	1.54	69.94	80.96	150.40	150.10
C. V. (%)	7.72	8.28	8.09	7.09	8.83	11.49	8.46	10.56

Table 3 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**
T0	83.67	62.00	81.33	75.67	34.57	42.50	60.30	45.79	4.67	4.00	8.93	5.87
T1	94.33	69.00	86.67	83.33	58.80	61.17	69.00	62.99	7.37	4.23	9.53	7.04
T2	98.33	79.00	86.67	88.00	55.97	71.07	73.33	66.79	6.18	5.77	8.50	6.82
T3	86.33	67.33	85.33	79.67	50.13	59.20	75.30	61.54	7.92	4.20	9.03	7.05
T4	86.00	77.33	81.33	81.56	73.24	74.83	73.33	73.80	8.03	6.07	9.33	7.81
T5	89.67	63.33	96.00	83.00	89.57	71.67	76.67	79.30	8.32	4.80	9.77	7.63
T6	92.33	65.33	94.67	84.11	99.36	71.21	90.00	86.86	8.58	5.47	10.83	8.29
T7	96.33	72.00	93.33	87.22	98.21	57.90	80.00	78.70	9.02	4.50	9.27	7.59
T8	85.67	73.67	92.00	83.78	56.35	60.00	84.20	66.85	6.42	4.33	9.10	6.62
T9	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

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Table 4 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
T0	2.85	1.17	2.32	2.11	1.33	1.74	1.67	1.58	4.18	2.90	3.99	3.69
T1	3.93	1.31	2.55	2.60	2.45	1.91	1.87	2.08	6.38	3.22	4.42	4.67
T2	4.97	1.46	2.65	3.03	2.31	2.22	1.91	2.15	7.28	3.68	4.56	5.17
T3	3.69	1.45	2.83	2.66	1.94	2.44	2.04	2.14	5.63	3.89	4.87	4.80
T4	4.03	1.37	1.78	2.39	1.68	2.23	2.09	2.00	5.71	3.60	3.87	4.39
T5	5.20	1.24	2.80	3.08	2.09	2.06	2.05	2.07	7.29	3.30	4.85	5.15
T6	4.07	1.47	3.02	2.85	2.08	2.25	2.10	2.14	6.15	3.71	5.12	4.99
T7	4.74	1.36	2.81	2.97	2.07	1.76	2.10	1.97	6.81	3.12	4.91	4.94
T8	2.40	1.44	2.83	2.22	1.09	2.21	1.93	1.74	3.49	3.65	4.75	3.96
T9	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. ±	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 5 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
T0	350	180	325	285	390	248	728	455
T1	602	222	384	403	695	292	830	605
T2	715	291	395	467	607	456	736	600
T3	486	263	416	388	683	282	770	578
T4	490	278	315	361	691	468	758	639
T5	654	209	466	443	745	304	937	662
T6	568	243	486	432	793	357	1027	726
T7	656	224	459	447	869	324	864	686
T8	298	269	437	335	555	319	838	571
T9	490	273	486	417	938	416	1026	793
S.Em. ±	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

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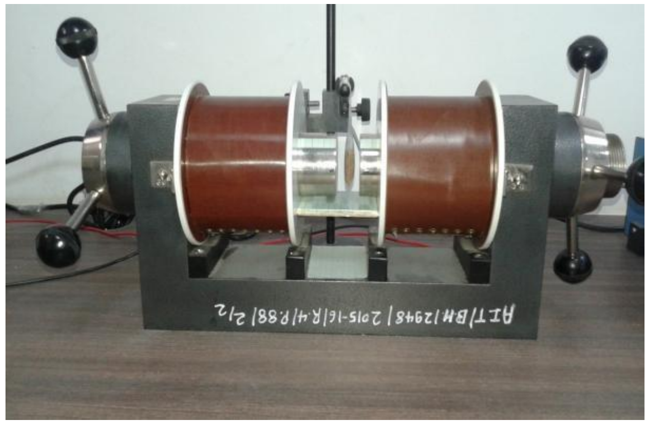
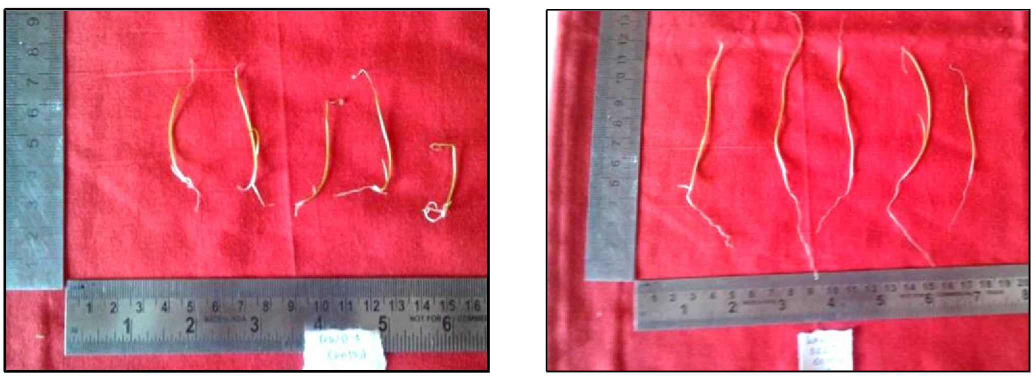
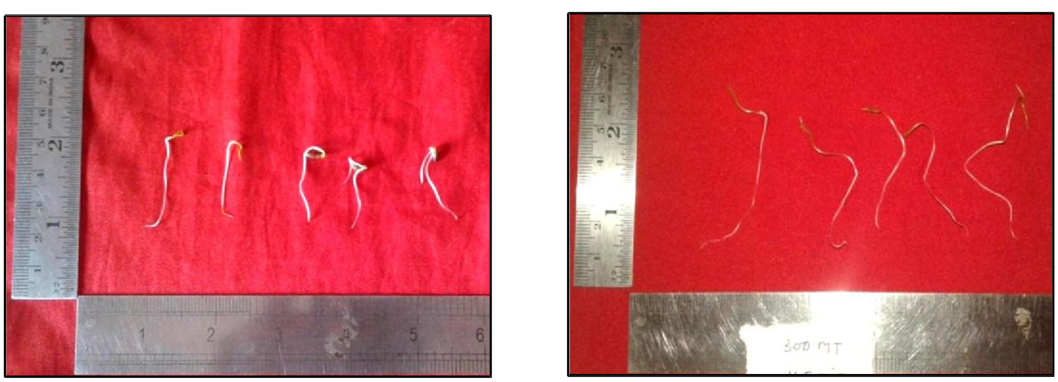


Fig. 1: Electromagnetic field generator with variable magnetic field strength



T1: Control T3: 20 mT magnetic field for 60 minutes

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



T0: No Magnetic Field (Control) T9: 300 mT magnetic field for 45 minutes

Fig. 3: Effect of magnetic field exposure on cumin seeds