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Effect Of Magnetic Field On Germination And Seedling Growth Of Onion

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Abstract: A laboratory trial was conducted during two years of 2018 and 2019 at College of Agricultural Information Technology, Anand Agricultural University, Anand, Gujarat to study the effect of magnetic field on germination and seedlings growth of onion. The samples were exposed with three levels of static magnetic field intensities of 20, 40 and 60 mT having 15, 30 and 60 minutes of exposure time. The seed of onion variety "GAWO 2" was taken for this experiment. From the experimental results, it was found that the exposure of magnetic field increased the germination rate, seedling fresh and dry weight, root and shoot length as well as seedling vigour as compared to no exposure. However, exposure of 20 mT magnetic field applied to the onion seeds for 60 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

Magnetic seed treatment is one of the physical pre-sowing seed treatments that have been reported by many workers to enhance the performance of crop plants. 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.

Globally, onion is an important vegetable crop. According to the available FAO data, onion is now the third most important vegetable (after tomato and cabbage) produced in the world. Since many years one has been observing problems with storing onion seeds. Seeds generally have a relatively short storage life and viability decreases rapidly. The main reasons of low quality of onion seed listed: Long flowering period resulted in different stages of seed maturity in the umbel and suboptimal storage conditions as high temperature and relative humidity (Brocklehurst, *et al.*, 1985). Its seeds are quite expensive as they lose their germination capacity quickly. Compared with many other crops, the onion has a fairly complex life cycle involving several distinct development phases. The onion seed is one of the shortest lived seeds of the common vegetable crops, rapidly losing viability after harvest unless special precautions are taken for its storage. For this reason, it is generally recommended that only fresh onion seed can be used for crop production (Riekels *et al.*, 1976). Therefore, to find out the any alternatives of improving the viability and germination of onion seed with exposure of static magnetic field this experiment was conducted.

RESEARCH METHODOLOGY

The laboratory experiment was conducted during the years 2018 and 2019 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 onion. The one year old seed of onion variety "GAWO 2" which was released from Anand Agricultural University, Anand was used in the experiment. There were ten different treatments of magnetic field exposure with different time interval *viz.* T_0: No magnetic field (Control), T_1: 20 mT Magnetic field given to seed for 15 min., T_2: 20 mT Magnetic field given to seed for 30 min., T_3: 20 mT Magnetic field given to seed for 60 min., T_4: 40 mT Magnetic field given to seed for 15 min., T_5: 40 mT Magnetic field given to seed for 30 min., T_6: 40 mT Magnetic field given to seed for 60 min., T_7: 60 mT Magnetic field given to seed for 15 min., T_8: 60 mT Magnetic field given to seed for 30 min., T_9: 60 mT Magnetic field given to seed for 60 min. The experiment was analysed with Completely Randomized Design repeated thrice. After exposure of magnetic field, the treated seeds were stored up to 7 days period as a means of transportation period from lab to land conditions. After that, the seeds left 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.

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).

Magnetic treatment

Onion seeds were exposed to the magnetic field of 20 – 60 mT in steps of 20 mT for 15, 30 and 60 minutes respectively, for all field strengths in a small plastic bag, made up of a non-magnetic thin transparent polyethylene plastic sheet. A sample of 100 visibly sound, mature, healthy seeds were held in the plastic container 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 than10 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 ^{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

$$\text{Seedling Vigour Index – I} = \text{Germination \% x Seedling length}$$

$$\text{Seedling Vigour Index – I} = \text{Germination \% x Seedling dry weight}$$

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 (T_3) recorded significantly higher germination percentage than all treatments except treatments T_5 during the year 2018 while T_5 and T_6 during the year 2019 which were at par with treatment T_3. 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 T_3 (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 T_3 over all the treatments except treatment T_4 (40 mT magnetic field exposure given to the seeds for 15 minutes) which was at par with treatment T_3. 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. Significantly the highest seedling fresh weight was recorded under the treatment T_3 during the year 2018 while treatment T_3 observed significantly higher seedling fresh weight over all treatments except treatments T_4 and T_9 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 (T_3) during both the years. Exposure of magnetic field on chickpea seeds gave positive reponse 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.

CONCLUSION

Exposure of onion seeds to static magnetic field increased laboratory germination, seedling root, shoot and seedling length, fresh and dry weights significantly compared to without magnetic field treated seeds (control). Among the various treatments of magnetic field and time duration, exposure of 20 mT magnetic field for 60 minutes gave best results. Onion 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, 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
T_0	62.83	59.67	2.17	2.70	4.57	5.64	6.73	8.34
T_1	77.17	60.33	2.92	2.79	5.61	6.48	8.53	9.27
T_2	76.00	61.00	3.18	3.05	6.03	6.08	9.21	9.13
T_3	83.00	67.83	4.22	3.59	6.67	7.20	10.90	10.79
T_4	71.00	57.33	2.57	3.77	5.81	6.77	8.38	10.55
T_5	78.67	69.50	3.47	2.77	6.00	5.88	9.47	8.65
T_6	75.17	66.33	3.45	3.19	6.59	5.90	10.03	9.10
T_7	69.67	60.67	2.83	2.95	6.48	7.12	9.31	10.07
T_8	74.00	59.33	2.84	3.15	5.95	6.12	8.79	9.27
T_9	72.33	60.00	3.44	2.87	6.55	6.19	9.99	9.06
S.Em. $\pm$	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
T_0	183.27	282.87	17.18	16.07	423	511	1070	1019
T_1	342.00	299.17	21.12	16.80	659	579	1710	1080
T_2	317.43	327.53	21.68	18.00	702	596	1704	1175
T_3	398.50	381.40	22.22	20.73	903	748	1884	1457
T_4	227.67	356.27	20.63	19.34	591	631	1410	1203
T_5	311.50	343.20	22.97	17.10	744	617	1679	1243
T_6	351.83	327.73	22.30	19.03	746	627	1603	1296
T_7	255.67	343.17	20.68	19.53	648	620	1365	1227
T_8	302.50	323.80	20.45	19.87	648	560	1314	1230
T_9	279.57	352.70	22.27	19.77	723	552	1503	1257
S.Em. $\pm$	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

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

T_1: Control

T_3: 20 mT magnetic field for 60 minutes

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