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Research Article

Electro-Magnetic Field Treatments to Onion Seeds (A*llium cepa* L.) to Enhance Storability

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ABSTRACT

Effect of electro-magnetic field treatments on germination of seeds and other quality parameters in onion were studied under the laboratory condition. Fresh onion seeds (*var*. *Arka kalyan*) were exposed to 1, 10, 50 and 100 Hz pulsed electro-magnetic fields of 1500 nT (nano Tesla) for 5 h d^{-1} for 15 days. Unexposed seeds were used as control. Seeds were stored for 10 months under the ambient condition and various quality attributes *viz.,* germination, seedling length, dry weight and vigour indices were recorded at bimonthly interval. Maximum values of seed germination (75%), seedling length (13.6 cm), seedling dry weight (1.89 mg per seedling) and seed vigour indices (965 and 142) was recorded on exposure of seeds to 10 Hz electromagnetic frequency. Increase in germination and vigour index-I was 12.49 and 24.35%, respectively. Increase in seed moisture content was also minimal in treated seeds. Magnetic treatments can be useful to enhance the seed quality and storage potentiality of onion.

Key words: Pulsed Electro-Magnetic Field (PEMF), Seed quality, Onion

Introduction

Onion (*Allium Cepa L.*) is the third most important vegetable in the world, and earns the highest foreign exchange among all horticultural crops. India has the largest area under onion cultivation and ranks second in production after China, with global output of 19.9% covering an area of 1.064 Mha with 15.12 Mt of production (Indian Horticulture Database, 2011). Seed production methods, inadequate supply of quality seeds and high cost of seed have been major limitations in onion production. Sensitivity of the crop to rapidly lose its germination ability and vigour leads to huge loss. The long flowering period at different stages of seed maturity in the umbel and suboptimal storage conditions such as high temperature and relative humidity may also result in low quality of onion seeds. Hence, enhancing/promoting the longevity of the crops through simple, cost-effective and eco-friendly agricultural practice, and maintenance of integrity of the seeds are the major challenges. The electric and magnetic field treatments are useful non-chemical methods for seed quality enhancement (Das and Bhattacharya, 2006).

Electro-magnetic field treatment is an environment-friendly and inexpensive method to enhance seed germination and seedling growth (Podlesny, 2004). This could be attributed to the physical activation of ions, free radicals and electric charges without a change in the chemical profile of the seed. This makes the membrane permeable and thus, accelerates the metabolic pathways by enhancing the bio-chemical and

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physiological feedback (Naz *et al*. 2012). Jamil *et al*. (2012) suggested that the physical treatments are safer than the chemical treatment. Kordas (2002) mentioned role of magnetic field treatment of seeds in stimulating plant growth, proteins biosynthesis and root development. Effect of magnetic field treatment to wheat, maize, sunflower, barley, corn, beans, tomato and fruit seeds showed improved performance of plant growth, height, seed weight, yield, and shoot and root lengths (Moon and Chung, 2000; Aladjadjiyan, 2002; Dagoberto *et al*., 2002; Harichand *et al*., 2002; Martinez *et al*., 2002; Socorro and Carbonell, 2008; Fischer *et al*., 2004; Florez *et al*., 2007). Low frequency magnetic field had a positive effect on germination of onion seeds (Kubisz *et al*., 2012). Keeping this in background, the effect of pulsed electro-magnetic field (PEMF) treatments were evaluated on seed quality and storability of the onion seeds, and is reported here.

Materials and Methods

The storage experiment was carried out in the Seed Technology Research Unit, AICRP on NSP, GKVK, Bangalore during the year 2014-15 with the objective to prolong the longevity of the onion seeds by exposing them to PEMF treatments. Healthy, fresh and uniform sized onion seeds were procured from MPKV, Rahuri and brought to Madras Institute of Magnetobiology, Chennai. Each batch of 250 g of seeds were exposed to 1, 10, 50 and 100 Hz PEMFs of 1500 nT for 5 h d^{-1} for 15 days to determine the optimal frequency for best performance. Control seeds were kept under similar conditions (no PEMF). Treated seeds with PEMF were sent to UAS, Bangalore to record the initial seed quality parameters and the seeds were stored in cloth bag under ambient conditions, where minimum and maximum temperatures recorded were 14 to 22^{0}C and 28 to 32^{0}C, respectively, and the mean relative humidity was 59 to 86%. Seed quality attributes were evaluated at bi-monthly intervals. The seeds were stored for ten months (July 2014 to April 2015). Seeds were tested for germination by adopting top of the paper (TP) method at 25±1^{0}C. Total germination was expressed in percentage on the basis of the number of normal seedlings obtained. The moisture content was estimated by low constant temperature method as per the procedure outlined by ISTA (2013). Ten seedlings were randomly selected, lengths (cm) were measured, and then dried in hot air oven at 85^{0}C for 12 h to obtain dry weights (mg per seedling). Seedling vigor index (SVI-I and II) was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed in whole number.

Results and Discussion

Exposure of onion seeds to PEMF at different frequencies showed an overall stimulating effect on the percent germination and related characters such as seedling length (cm), dry weight (mg/ seedling) and vigour indices over untreated (control) seeds. With regard to germination, significant increase in germination percentage from 1.2 to 10.3% was observed among all the treated seeds over the untreated control (Table 1). However the highest germination was recorded in seeds exposed to 10 Hz electromagnetic frequency (75.0%) followed by 1 Hz (71.7%) over untreated control (66.7%) after 10 months of storage (Fig. 1). The resultant increase over control was almost 12.5% among T_3 (10 Hz) and 7.5% among T_2 (1 Hz). The lowest values were observed among the seeds treated with 50 and 100 Hz PEMF. This clearly indicates the importance of magnetic strength in enhancement of quality of seeds. Utility of the low frequency magnetic field treatments gave better results compared to high frequency of magnetic strength. It was interesting to observe that the seeds exposed to PEMF maintained minimum seed certification standard (Germination > 70%) even after 10 months of storage, while there was a sudden fall in the germination ability after 8 months of storage in untreated control seeds. The mechanism of seed germination stimulation might be attributed to changes in biochemical and physiological processes, and as acceleration in metabolism and that of enzymes accelerated activities (Podlesny *et al.,* 2003). It was observed that significant highest germination in rice was recorded on exposure to 125 mT/250 mT magnetic fields for

Table 1. Effect of electro-magnetic field treatment on seed germination (%) and moisture content (%) after 10 months of storage

Treatments	Seed Germination (%)					Seed Moisture content (%)				
	2MAS	4MAS	6MAS	8MAS	10MAS	2MAS	4MAS	6MAS	8MAS	10MAS
T_1-Control	84.33	81.33	77.33	71.67	66.67	9.67	8.18	11.36	10.5	10.01
T_2-1Hz	89.00	84.67	82.33	76.33	71.67	9.88	7.94	10.55	9.96	9.76
T_3-10Hz	90.00	85.67	83.33	77.67	75.00	9.56	7.84	10.66	9.91	9.72
T_4-50Hz	88.00	82.33	80.00	75.00	71.00	9.78	8.11	10.72	10.11	9.84
T_5-100Hz	85.00	83.33	77.67	72.67	71.00	9.89	8.07	10.92	10.4	9.81
SEm±	1.25	1.89	1.68	1.27	1.61	0.13	0.08	0.10	0.08	0.04
CD (P=0.05)	3.93	5.96^{NS}	5.29^{NS}	4.01	5.06^{NS}	0.41^{NS}	0.26^{NS}	0.329	0.264	0.142
CV(%)	2.47	3.92	3.63	2.95	3.91	2.31	1.81	1.66	1.81	0.79

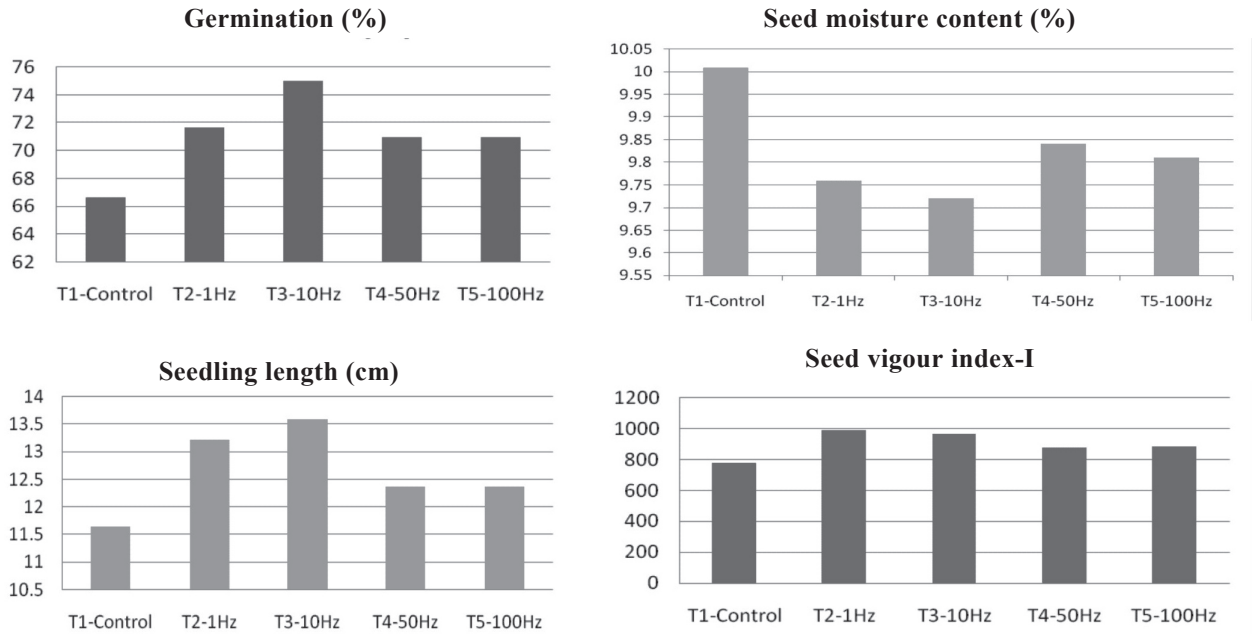

Fig. 1. Seed Quality parameters as affected by pulsed electro-magnetic field treatments after 10 months of storage

specific time intervals, which indicates a particular combination of magnetic field strength and exposure duration results in maximum possible stimulation (Florez *et al.,* 2004; 2007). It is well understood from the literature that the best outcome of seed germination is possible when optimal exposure doses are applied. Various studies clearly showed that magnetic field treatment with shorter expose-time performed better over higher doses for longer exposure in germination rate (Florez *et al.,* 2007; Zia ul Haq *et al.,* 2012).

The seed moisture content is one of the most important factors affecting the seed viability/ longevity during storage. An increase in seed moisture content was lower among the treated seeds. However, seeds exposed to 10 Hz electro-magnetic frequency recorded lowest moisture (9.7%) content as compared to control (10.0%) (Table 1; Fig 1).

Seed stimulation with PEMF also had profound effect on later stages of growth and development. Seeds exposed to 10 Hz frequency recorded highest seedling length (13.6 cm). This

Table 2. Effect of pulsed electro-magnetic treatment on seedling length (cm) and seedling dry weight (mg) after 10 months of storage (MAS)

Treatments	Seedling length (cm)					Seedling dry weight (mg)				
	2MAS	4MAS	6MAS	8MAS	10MAS	2MAS	4MAS	6MAS	8MAS	10MAS
T_1-Control	16.85	16.52	15.27	12.17	11.64	1.93	1.80	1.87	1.64	1.52
T_2-1Hz	18.09	16.99	16.90	14.90	13.22	2.13	2.00	2.00	1.70	1.75
T_3-10Hz	18.78	18.09	17.24	15.13	13.59	2.07	2.20	2.13	1.86	1.89
T_4-50Hz	16.93	17.20	16.54	14.33	12.36	2.03	1.73	1.90	1.57	1.60
T_5-100Hz	17.09	16.85	16.44	13.00	12.37	1.97	1.83	1.83	1.52	1.51
SEm±	0.32	0.30	0.39	0.51	0.37	0.07	0.09	0.09	0.06	0.06
CD (P=0.05)	1.02	0.96	1.22	1.61	1.16	0.21^{NS}	0.28	0.29^{NS}	0.18	0.17
CV (%)	3.207	3.07	4.08	6.37	5.05	5.70	7.98	8.28	6.05	5.83

NS-Non significant

Table 3. Effect of pulsed electro-magnetic treatment on Vigour Index-I and and Vigour Index-II after 10 months of storage (MAS)

Treatments	Vigour Index-I					Vigour Index-II				
	2MAS	4MAS	6MAS	8MAS	10MAS	2MAS	4MAS	6MAS	8MAS	10MAS
T_1-Control	1420	1345	1180	872	776	163	147	144	118	101
T_2-1Hz	1609	1438	1391	1136	991	190	169	165	130	125
T_3-10Hz	1690	1549	1437	1174	965	186	188	178	144	142
T_4-50Hz	1490	1417	1324	1074	880	179	143	152	118	114
T_5-100Hz	1454	1403	1276	945	886	167	153	142	110	107
SEm±	29.88	45.24	41.26	30.98	35.44	6.12	9.19	6.30	3.88	4.06
CD (P=0.05)	94.17	142.55^{NS}	130.02	97.61	111.68	19.29	28.97	19.86	12.21	12.80
CV (%)	3.38	5.47	5.41	5.16	6.82	5.99	9.95	6.98	5.414	5.97

NS-Non significant

accounts for an increase of 16.8% over control (11.6 cm). The next best treatment was T_2 (1Hz PEMF) with 13.6% increase over the control. On the whole, treated seeds performed superior over the control. Similar results have been reported as considerable improvement in germination characteristics in maize and chickpea seeds when treated magnetically (Aladjadjiyan, 2002; Fischer *et al.,* 2004; Florez *et al.,* 2007; Vashisth and Nagarajan, 2007 and 2008).

These treatments also had a remarkable effect on the seedling dry weight and calculated vigour indices (Table 2 & 3). Significantly higher dry weight (1.89 mg/seedling) and vigour index-I (965) were recorded in T_3 (10 Hz PEMF) each accounting to an increase of 24.0% over control. This was followed by T_2 (1Hz) with dry weight (1.75 mg/seedling) and vigour index-I (991). The lowest of both was recorded in untreated control (1.52 mg/seedling & 776 respectively). Increased physiological activity due to greater absorption of moisture by treated seeds might be responsible for overall increase in seedling length, dry weight and vigour indices. Waleed *et.al* (2013) reported that root length and root dry weight increased by 18.0 and 0.52%, respectively on exposure of wheat seeds to magnetic field of 50mT/30min.

Conclusions

The present study indicated that the PEMF had positive effect in enhancing the storage potentiality of onion seeds. Different magnetic field strength treatments increased the germination rate almost by 1.2-10.3%. The

increasing rate was higher when the seed were treated particularly at the optimum magnetic strength viz., 10Hz frequency followed by 1Hz and the lowest was observed with higher dose of PEMF frequency viz., 50 and 100 Hz. Hence the electro-magnetic field treatments can serve as the best and low cost technology to enhance the vigour and storability of the various crops.

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