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Effect of Pulsed Electro-magnetic Field Treatments on Seed Quality of Onion Seeds (*Allium cepa* L.)

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ABSTRACT

The effect of pulsed electro-magnetic field treatments on the seed germination and other quality parameters were studied under the laboratory condition. The fresh lots of onion seeds (*var. Arka kalyan*) were exposed to 1.0, 10.0, 50.0 and 100.0 Hz (Hertz) pulsed electro-magnetic fields of 1500nT (nano Tesla) for 5 hrs per day for a period of 15 days. The non exposed seeds were used as control. The seeds were stored in light under the ambient condition of Bangalore and various seed quality attributes were recorded at bimonthly interval. At the end of 10th month of storage period, the onion seeds maintained the seed quality parameters *viz.*, seed germination, seedling length, dry weight and vigour indices. Significant highest germination (75%), seedling length (13.59cm), seedling dry weight (1.89 mg/seedling) and seed vigour indices (965 & 142) were recorded in T_3 *viz.*, on exposure of seeds to 10 Hz electromagnetic frequency as compared to control (66.67%, 11.64cm, 1.52 mg / seedling, 776 and 101, respectively). The per cent increase in germination and vigour index-I was to the tune of 12.49 and 24.35 per cent, respectively. The next best treatment was T_2 *viz.*, exposure of seeds to 1 Hz electromagnetic frequency accounting for an increase in germination by 7.5 per cent over control. Increase in seed moisture content was also minimal in treated seeds compared to control. Hence, these treatments can be practically useful to enhance the seed quality and stora ge potentiality of onion.

Keywords: Pulsed electro-magnetic field (PEMF), intensity-nano tesla, frequency-hertz, onion and storage

ONION (*Allium cepa* L.) is one of the most important vegetable crops used for consumption and highest foreign exchange earner among horticultural crops. India has the largest area under onion cultivation and ranks second in production after China with global output of 19.9 per cent covering an area of 1064 ha with a production of 15118 thousand tons. It is the third most important vegetable producer in the world. Seed production methods, inadequate supply of quality seeds and high cost of seed has been major handicaps in increasing area and productivity of onion. Also the sensitivity of the crop to loose its germination and vigour rapidly has led to huge loses to the seed companies all over the world. 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 have resulted in the low quality of onion seeds. Hence, enhancing / promoting the longevity of the crops through simple, cost-effective eco-friendly agricultural practice and maintenance of integrity of the seeds is a major challenge. Researchers world wide have reported on the influence of electro-magnetic field treatments on seed quality enhancement and crop performance in terms of growth and yield. Das and Battacharya, 2006 stated that electric and magnetic field treatments are used as a non-chemical method in agriculture for seed quality enhancement.

In this regard, electro-magnetic field treatment is secure and in-expensive method used to enhance the seed germination and seedling growth (Podlesny, 2004). The magnetic field treatments tend to enhance the concentration of ions, free radicals and electric charges physically without any alteration in the chemical profile of the seed and make the membrane permeable. Free movement of ions activates the metabolic pathways by enhancing the bio-chemical and physiological feedback (Zia ul Haq *et al*., 2012). Jamil *et al*. (2012) suggested that the physical treatments are safer than the chemical ones. Kordas (2002) mentioned that magnetic field treatment of seeds leads to acceleration of plant growth, proteins biosynthesis and root development. The study on

various crops *viz.,* wheat, maize, sunflower, barley, corn, beans, tomato and fruit seeds treated with magnetic field showed high performance of plant growth, height, yield, seed weight per spike as well as shoot and root length, total fresh and dry weights (Florez *et al.*, 2007 and Socorro & Carbonell, 2002). Low frequency magnetic field had a positive effect on germination of onion seeds (Kubisz *et al.*, 2012). Hence, the present study was carried out to evaluate the effect of pulsed electro-magnetic field treatments on seed quality and storability of the onion seeds.

Material and Methods

The storage experiment was carried out in Seed Technology Research Unit, AICRP on NSP, GKVK, Bangalore, India during the year 2014-15 with an objective to prolong the longevity of the onion seeds by exposing them to Pulsed Electro-Magnetic Field treatments. Freshly harvested onion seeds were sent from MPKV, Rahuri to Madras Institute of Magneto-Biology Chennai, India for treatment. At Chennai, the healthy uniform size seeds were selected and each batch of 250 g of seeds were exposed to 1.0, 10.0, 50.0 and 100.0 Hz PEMFs of 1500 nT for 5 h per day for a period of 15 days to determine optimal frequency. Control seeds were kept under similar conditions in the absence of PEMF. The treated seeds with PEMF were sent to UASB for further studies. Soon after the receipt of treated seeds, the initial seed quality parameters were recorded and the seeds were stored in cloth bag under the ambient conditions of Bangalore where minimum and maximum temperature recorded was 14°C to 22°C and 28°C to 32°C, respectively and the mean relative humidity was 59.0 to 86.0 per cent. The total geo-magnetic field strength in the place of stimulation was 41,223.5nT and shape of stimulus was sinusoidal. Seed quality attributes were evaluated at bi-monthly intervals. The seeds were stored in light for period of ten months (July, 2014 to April, 2015). Seeds were tested for germination by adopting top of the paper (TP) method at 25±1°C. The total germination was expressed in percentage on the basis of number of normal seedlings obtained. The moisture content was estimated by low constant temperature method as per the procedure outlined by Anon. (2013). The mean seedling length was computed and expressed in Centimeter. Ten seedlings selected randomly to measure the length were dried in hot air oven at 85°C for 12 hours to obtain the dry weight which was expressed in milligrams per seedling. Seedling vigor index (SVI-I & II) was calculated by adopting the method suggested by Abdul-Baki and Anderson (1973) and expressed in whole number. The statistical design used for analysis was CRD (complete randomized design).

Results and Discussion

Exposure of onion seeds to pulsed electro-magnetic fields at different frequencies showed an overall stimulating effect on the per cent germination and related characters such as seedling length (cm), dry weight (mg/seedling) and calculated vigour indices over untreated control seeds (Fig. 1). But, however the highest germination was recorded in seeds exposed to 10 Hz electromagnetic frequency (75%) followed by 1Hz (71.67%) over untreated control (66.67%) after 10 months of storage (Table I). The resultant increase over control was almost 12.49 per cent among T_3 (10Hz) and 7.49 per cent among T_2 (1Hz). 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, physiological processes as well as acceleration in metabolism and that of enzymes accelerated activities (Podlesny *et al.*, 2003). Florez *et al.*, 2007 reported on significant increase in seed germination of rice when exposed to 125 mT/250 mT magnetic fields for specific time intervals, which indicates that the better results are dependent to specific magnetic field strength and exposure duration. It is well understood from the literature that the best outcome of seed germination is possible when optimal exposure doses are applied. It has been widely reported that different doses of magnetic field treatment

TABLE I

Effect of electro-magnetic field treatment on seed germination (%) and moisture content (%) during storage

Treatment	Seed Germination (%)					Seed Moisture content (%)				
	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS
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 ±	1.247	1.892	1.68	1.274	1.606	0.13	0.084	0.104	0.084	0.045
CD (P=0.05)	3.93	5.960 NS	5.29 NS	4.013	5.06 NS	0.411 NS	0.264 NS	0.329	0.264	0.142
CV(%)	2.47	3.925	3.63	2.95	3.91	2.31	1.808	1.66	1.808	0.795

NS-Non significant

MAS – Months After Storage

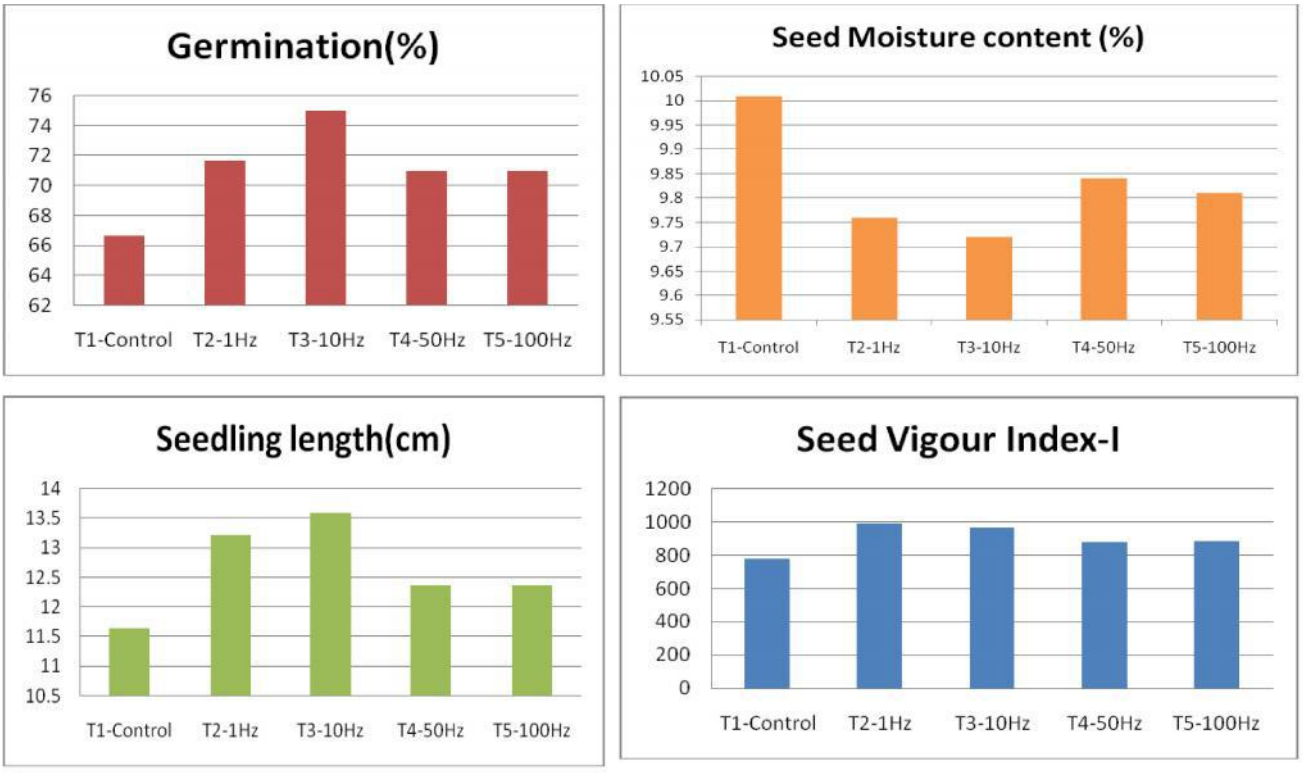

Fig 1: Seed Quality parameters as affected by pulsed electro-magnetic field treatments

stimulate seed germination and seedling growth for shorter exposure time, while that of higher doses for longer time having no significant improvement in germination rate (Zia ul Haq *et al.,* 2012 and Florez *et al.,* 2007).

The seed moisture content is one of the most important factors affecting the seed viability/longevity during storage. The increase in the seed moisture content was minimal among the treated seeds as compared to control. But however, the seeds exposed to 10 Hz electro-magnetic frequency recorded lowest moisture (9.72%) content as compared to control (10.01%) even after 10 months of storage (Table I).

Seed stimulation with electro-magnetic field also had a profound effect on later stages of growth and development. The seed exposed to 10 Hz electro-magnetic frequency has recorded highest seedling length (13.59cm). This accounts for an increase of 16.75 per cent over control (11.64cm). The next best treatment was T_2 (1Hz PEMF) with seedling length (13.22cm) (Table II). On the whole the treated seeds performed better compared to control. Similar results have also been reported by various researchers for seeds of different crops. Considerable improvement in germination characteristics such as seedling vigor, shoot and root growth was observed in maize and chickpea seeds when treated magnetically (Florez *et al.,* 2007; Vashisth & Nagarajan, 2007 and Vashisth & Nagarajan, 2008). These treatments also had a remarkable effect on the seedling dry weight (Table II). Significant highest dry weight (1.89 mg/seedling) was recorded in T_3 (10 Hz PEMF). This was followed by T_2 (1Hz) with dry weight (1.75 mg/seedling). While, lowest was recorded in untreated control (1.52 mg/seedling). The increased physiological activity due to greater absorption of moisture by treated seeds may be responsible for overall increase in seedling length and dry weight. Waleed *et al.* (2013) reported that the root length, dry weight of root increased by 18 and 0.52 per cent, respectively on exposure of wheat seeds to magnetic field of 50mT/30min.

Similarly, the 10Hz PEMF magnetic field treatment was found better for onion seed storage with highest seedling vigour index I and II (965 and 142) during 10 months of storage (Table III). This was

TABLE II

Effect of pulsed electro - magnetic treatment on seedling length (cm) and seedling dry weight (mg) during storage

Treatment	Seedling length (cm)					seedling dry weight (mg/seedling)				
	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS
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±	0.324	0.304	0.388	0.511	0.369	0.067	0.088	0.093	0.058	0.056
CD (P=0.05)	1.021	0.957	1.223	1.611	1.162	0.21 NS	0.278	0.293 NS	0.182	0.175
CV (%)	3.197	3.071	4.081	6.37	5.054	5.698	7.984	8.28	6.046	5.83

NS-Non significant

MAS – Months After Storage

TABLE III

Effect of pulsed electro-magnetic treatment on Vigour Index - I and Vigour Index - II during storage

Treatment	Vigour Index - I					Vigour Index - II				
	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS	2 MAS	4 MAS	6 MAS	8 MAS	10 MAS
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	41.262	30.976	35.442	6.123	9.194	6.302	3.876	4.063
CD (P=0.05)	94.17	142.55 NS	130.02	97.61	111.68	19.293	28.97	19.857	12.213	12.804
CV (%)	3.38	5.47	5.41	5.16	6.82	5.99	9.95	6.98	5.414	5.97

NS-Non significant; MAS – Months After Storage

followed by T_2 (1Hz) with vigour index-I (991) and vigour index-II (125). Therefore, it can be concluded that vigor of seed in untreated control seeds over time of storage due to more moisture absorption.

The present study indicated that the electro-magnetic field treatments had a positive effect in enhancing the storage potentiality of the onion seeds. 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 electro-magnetic frequency *viz.*, 50 and 100 Hz. Hence, the electro-magnetic field treatments can serve as a best and low cost means to enhance the vigour and storability of the various crops.

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