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INFLUENCE OF ELECTROTHERAPY AND SALT PRIMING TO IMPROVE GERMINATION AND VIGOUR OF WHEAT SEEDS

Arindam Mandal[1] and Niranjan Bala[2]

ABSTRACT

In this current study seeds of wheat (*Triticum aestivum*) primed with salts solution [1:1 (v/v) of 0.05% KNO_3 and 0.05% $Ca(NO_3)_2$] and an electric stimulus (DC 300V & 400mA) was passed for 6 minutes (EC6) and 11 minutes (EC11) between two electrodes in a horizontal casting container containing the same salt mixture. Effects of these seed priming treatments on germination %, speed of germination, TR values, shoot length, root length, vigour index, mass accumulation, electrical conductivity, peroxidase and alpha-amylase activities were measured and compared with non-primed control seeds. Electrotherapy (EC6) for six minutes on pre-sown soaked seeds enhanced the physiological and biochemical parameters by establishing a vigorous seedling within a stipulated time. Salt priming also established a vigorous seedling but significantly lower than treatments EC6 and EC11, but it was significantly enhanced all parameters studied when compared with control and water treatments. Electric stimulus and salt priming may be suitable for better germination and vigour of wheat seeds for rain fed cultivation.

(Key words. Electrotherapy, *Triticum aestivum*, germination, vigour, agriculture, alpha-amylase)

INTRODUCTION

The consciousness of the significance of better crop growth and its expression in productivity was happening from the pre-historical era. Until today, various aspects of better productivity of crops and their proper utilization were studied worldwide in different crops. Quality seed plays a vital role in this feature which is not to be considered as a crop growth planning due to its unavailability. To compensate for the demand for quality seed in addition to soil and environmental constraints, crop growth can be adapted in different ways of which seed treatment is one of them.

Wheat (*Triticum aestivum*) is considered a fundamental food item next to rice. It contributes to a large extent to national food safety by providing above 50% of the total calories to the people who generally depend on it. Starchy endosperm in cereal grain acts as a reservoir of storage compounds mobilized during germination to provide nutrients for the growth of germinating seedlings (Fincher, 1989). Mobilization of these storage compounds depends on the secretion and synthesis of hydrolytic enzymes from the aleurone layer and scutellum under the control of growth-promoting hormones (Dominguez and Francisco, 1995).

In West Bengal, the productivity of wheat and quality of seed is limited due to short winter spells and delayed sowing, particularly in rainfed which is recovered through upgrading the crop growth behaviour (Mukherjee, 2012). Presently, wheat cultivation occupies a large area of more than 27 million hectares. Bread wheat contributes approximately 95% to total production while another 4% comes from *Durum* wheat and *Dicoccum* share in wheat production remains only 1%. For cultivation in relation to quantity and quality, the differences related to constraints can be thrashed by selecting an appropriate technique under the seed treatment route. The inclusion of the technique can be optimized for the cultivation practice, especially in rainfed varieties which is more practical in West Bengal due to the exploitation of soil water and saving of underground water level.

After Green Revolution, India has incredibly advanced in wheat cultivation where the productivity and production increased to the tune of 523%, 460%, 559%, 606% and 780% respectively by the year 2000-01, 2005-06, 2010-11, 2015-16 and 2020-21 as compared to 1965-66 (Anonymous, 2021). The success story behind the bloom of wheat production mainly depends on the irrigation schedule. The wheat production is not stabilized during 2000-01 to 2008-09 depicting a growth rate of 1.77 due to unfavourable weather conditions. Hence, the emphasis must be given to limited irrigation and rainfed or accurate management of irrigation by consumption of appropriate techniques (Singh and Kumar, 2022). At present, the productivity of wheat is 35 q ha^{-1} in India though the cultivated high-yielding varieties have a strength of as much as 55–60 q ha^{-1}. The claim projection of wheat for 2025 has been anticipated to be about 109 million tons (Anonymous,

1. Asstt. Professor of Botany, Bejoy Narayan Mahavidyalaya, Hooghly, 712147, WB, India
2. Asstt. Professor of Botany, Sreegopal Banerjee College, Hooghly, 712148, WB, India

2007). At present, the productivity of wheat is 35 q ha^{-1} in India though the cultivated high-yielding varieties have a strength of as much as 55-60 q ha^{-1}. The claim projection of wheat for 2025 has been anticipated to be about 109 million tons (Anonymous, 2007). Population bloom will push the price of essential food items beyond the purchasing power of 696 million people below the poverty line (Anonymous, 2021). If the fluctuating production inclination continues, then achieving the target of wheat by 2025 will remain a difficult task. Different attempt has been made in different seed treatments in which electrotherapy on pre-sowing seed are one of them to surmount these crises. In the production of rainfed high-yielding wheat varieties, the establishment of seedlings is vital in a short duration which is very much compatible with the West Bengal situation due to late planting. The delayed establishment or poor establishment of a crop can create a configuration of low harvest index and yield. The establishment of poor and undersized seed shows an immediate effect and low storability, viability and vigour as a future effect for the coming season when it is utilized as seed material. The establishment of a good crop at the initial level increases the photosynthetic ability specifically depending on flag leaves and their effective tiller number (Fabre *et al.,* 2016). Many countries are engaged in scientific research relating to new varieties of plants and methods of their cultivation like genetic engineering, multi-seasonal selection, the protection of yields with the use of special plants and insects, bio-stimulation using external spectrums such as infra-red, ultra-violet, laser rays, ultrasounds, electric, magnetic and electromagnetic fields (Borisjuk *et al.,* 2019; Blûmmel *et al.,* 2016; Dorchester, 1935). Laser and magnetic field stimulation seem to be especially promising. This method does not cause any environmental changes, so it is desirable for ecological reasons (Mandal and Maity, 2013; Aladjadjiyan, 2007). Research work on the effect of magnetic fields on plant development and yielding has started in the last century. Electro-culture or electrotherapy is the use of electric current to promote the growth of plants. This cultural technique is known today but the idea is dated back to the 17th century. Dr. Von Maimbray of Edinburgh, Scotland observed for the first time that the rapid growth of myrtles tree was induced by an electrical field (Barman and Bhattacharya, 2016). Bose (1902) observed plant responses to electric current treatment, yet; so far it has not been fully exploited for commercial purposes. Electrical stimulus (electrotherapy) to pre-sowing seed is an innovative area of research and emerged as a magic tool that improves the yield of crops in an unprecedented manner which has not been achieved by any other technologies. Although this technology was first applied in cucurbitaceous plants to improve yield, now it has been extended to other crops like vegetables, cereals, pulses, oilseeds, etc. (Bera and Maity, 2004; Bera *et al.,* 2006; Pati, 2007). Electric current (EC) treatment may initiate physiological and biochemical changes which reflect growth and development processes in plants and ultimately the yield (Wahab *et al.,* 1980). Several workers reported yield improvement in various crops by application of this technology (Rahman and Yasmin, 1994; Zang and Hashinaga,1997). It has been evident that cell proliferation including the synthesis of DNA and RNA also induced by the application of an electromagnetic field (Ruediger, 2009). The application of electrical impulse decreases the time of dormancy and has shown significant improvement in seed germination and seedling growth (Gandhare and Samir, 2014; Zadeh *et al.,*2014; Aguilara *et al.,*2015).

The effect of electrotherapy on high-yielding Wheat variety (Genotype C-306) has been attempted to study in detail. Further electric current-mediated changes in germination profile, seedling growth parameters and seed biochemistry have been critically analyzed to develop early crop establishment for optimum production as well as its production of superior seeds for maintaining to achieve the projected production curve. The effect of electrotherapy on pre-sowing seeds of wheat was observed *in vivo* for checking the seedling quality to predict their future aspects.

MATERIALS AND METHODS

Seed samples

The experiment was conducted during the period from November to March of 2018-19 in the subtropical region of West Bengal. For the experiment high yielding varieties of *Triticum aestivum* having a genotype of C-306 collected from Bidhan Chanda Krishi Viswavidyalaya, Kalyani, India were used. Untreated self-pollinated air-dried seeds were used as control. Seeds soaked in distilled water for 4 hours were considered as water treatment. For salt treatment seeds were initially soaked in distilled water for 4 hours and then placed in a mixture of the electrolyte solution of 0.05% KNO_3 and 0.05% $Ca(NO_3)_2$ (1:1). To the water-soaked seeds an electrical stimulus containing DC 300V and 400 mA was passed for 6 minutes between two electrodes in a horizontal casting container containing the same salt mixture was treated as EC6. Treatments for EC11 were the same as EC6 but the electrical stimulus was passed for 11 minutes. For experimental purposes, all the treated seeds were air-dried properly. As there was no or minimum infestation of pests and disease, no plant protection measures were taken.

Experimental design

The experiment was laid out in a completely randomized design (CRD) having five treatments *viz.*, water, salt, and electric therapy for 6 minutes (EC6) and electric therapy for 11 minutes (EC11) with one control (untreated seeds) and replicated four times. The surface sterilized glass plate method was followed for the evaluation of seedling parameters. Seed treatments were done following a standard protocol (Chakraborty, 1998). The whole setup was then placed in the germinator at 27-30 ^{0}C. Statistical analysis was performed in the CRD fashion as suggested by Krzywinski and Altman (2014).

Seedling quality parameters

Twenty-five (25) seeds were randomly selected from each seed sample. Seed quality parameters were analyzed in laboratory conditions according to standard methods (Dahiya *et al.,* 1997). Germination percentage (%) was calculated on the 10th day by the formula, Germination % = Number of seeds germinated leading to normal seedling/ Total number of seeds used in the experiment x 100 (Hatzade *et al.,* 2022). The speed of germination was calculated with the help of the formula,Speed of Germination = Ó (n/t), Where, n= Number of seeds germinated, t= Time (days) from sowing. The first count was calculated by counting the number of germinated seeds (leading to normal seedlings) 3 days after placing them for germination test. On the 10th day, the average length of the root and shoot of the normal seedlings were measured and expressed in centimeter (cm). Vigour Index was calculated with the help of the formulae VI = SL × G, where, VI = Vigour Index, SL= Seedling Length (root length + shoot length), and G = Standard Germination Percentage (Abdul-Baki and Anderson, 1973).

Electrical Conductivity (EC)

Electrical Conductivity was measured from water containing leachate of seeds soaked in deionized water at 25^0 C for 24 hours in a beaker. EC of the water containing leachates of different treatments was measured from a direct reading of the conductivity meter (Model No. Systronics-306) with dip cell having a cell constant of 1.0 and was compared with a control set without any seeds (deionized water) (Humphreys *et al.,* 2004). Electrical Conductivity is expressed by micro-Siemen (ìS Sec.$^{-1}$).

Estimation of peroxidase activity

Peroxidase activity was measured according to Nakano and Asada (1981) using o-dianisidine as the substrate. Absorbance was recorded at 430 nm in Systronics-105 Spectrophotometer. Peroxidase activity = ÄA min.$^{-1}$ g^{-1} of imbibed seed. Where ÄA = difference in absorbance (0 min. to 1 min.)

Estimation of á-amylase

Extraction of á- amylase and the estimation of enzyme activities were done as per method suggested by Bernfield (1955). The enzyme activity was expressed as mcg (microgram) of maltose formed min.$^{-1}$ g^{-1} of fresh weight.

RESULTS AND DISCUSSION

In immediately harvested seeds germination % was non-significant. But it was maximum in treatments EC6 (electrical stimulus of DC 300V and 400 mA was applied for 6 minutes in water-soaked seeds), EC11 (same electrical stimulus was applied for 11 minutes), Salt (seeds were soaked in 1:1 mixture of 0.05% KNO_3 and 0.05% $Ca(NO_3)_2$) and water (seeds were soaked for 4 hours in water) over control (untreated). After 1 month of storage, a significant difference in germination was found between treatments salt, EC6 and EC11 as compared to the control (Table 1). The highest germination % was observed in treatments EC6 and EC11 followed by salt. After 4 months and 6 months of storage same patterns of germination was observed as observed in 1 month harvested seeds treatment. Treatment EC6 attributed a promising germination in all storage conditions and the next best was treatment EC11 followed by salt treatment. The germination % was gradually declined in different storage period, but electrotherapy improved the germination % which was highest in treatment EC6 followed by treatments EC11 and salt. Electric stimulus and salt priming mediated significant enhancement in germination was previously supported by the work of Wahab *et al.* (1980) and Feghhenabi *et al.* (2020).

Speed of germination in treatments EC6, EC11 and salt enhanced significantly over control in all storage periods (Table 2). In the case of immediate harvest, highest value observed in treatment EC6 which was non-significant to treatment EC11. At 1-month storage condition, there was no significant difference between salt and EC11 treatments but EC6 treatment always maintained a significant difference with the others representing the highest status. In the 4th month of storage period, there was a significant increase in speed of germination in treatment EC6 over all treatments. There was no significant difference between treatments EC6, EC11 and salt which was significantly higher than control and water. Significant increase in speed of germination was observed in treatment EC6 only over controls after 6 months of storage. The significant enhancement in first count % (TR value) was observed in freshly harvested seeds treated with treatment EC6 (72.32%) over other treatments except for the treatment EC11 (71.40%) (Table 3). The treatment EC11 also maintains a significant increased values over control, where as other treatments were indicated non-significant results. One month after storage again treatment EC6 showed the highest results which was significantly superior over treatment water and control. After 4 months of storage, an non-significant difference was found among the treatments salt, EC6, and EC11 but, these treatments were significantly higher than the treatments of water and control. The same trend was observed for different treatments in 6 months of storage, where treatment EC6 was showed their significance over all other treatments. Salt priming and electric current does a better job in the enhancement of TR value (Feghhenabi *et al*., 2020; Bera and Maity, 2004). The different isozymes and other assumed defense enzymes *viz*., endochitinase, exochitinase, protease, lectins, etc. are also found in seeds and may work together as a multi-component defense system to protect seeds during imbibition and germination (Lv *et al.,*2016).

Immediately after harvest, no significant differences in the root length was observed among treatments EC6, EC11 and Salt (Table 4). Treatment EC6 recorded significantly higher root length followed by treatments salt and EC11 over control. After 1 month and 4 months of storage, only the treatment water showed the significantly lowest root length in comparison to other treatments. In 6 months of storage condition treatments EC6, salt and EC11 indicated significantly more root length over control and water treatment, but the highest value was maintained by treatment EC6.

There was no significant difference between all treatments in freshly harvested seeds for shoot length, but the highest performance was reflected by treatment EC6 followed by treatments EC11 and salt (Table 5). After 1 month and 6 months of storage, significantly more shoot length was observed in treatments EC6, EC11 and salt over control and water treatment. In 4th month of storage, there was no significant difference among all treatments, but treatment EC6 showed the highest shoot length followed by treatments EC11 and salt respectively.

The vigour index of the freshly harvested seeds increased significantly in all treatments over control and the highest value was observed in treatment EC6 followed by treatments EC11, salt and water (Table 6). After 1 and 4 months of storage, the treatment EC6 created a significant and maximum outcome where an insignificant divergence was found between treatments salt and EC11. The vigour index was very low in 6th month of the storage period where significant diversity was found among all treatments but, the highest value was maintained by treatment EC6. Salt priming with electric stimulus and salt priming alone enhanced root length, shoot length which resulted superior vigour (Bera and Maity, 2004; Bera *et al.,* 2006).

Significant enhancement in fresh weight of all treatments were observed over control except water, whereas treatment EC6 showed the highest results in immediately harvested seeds (Table 7). There was no significant difference found between the treatments and the control but the highest fresh weight was achieved by treatment EC6 after 1 month of storage. After 4 and 6 months of storage period, significantly maximum fresh weight was observed in treatment EC6 over water and control treatments. The dry weight of immediately harvested seeds showed non-significant relationship with the control where salt represented the highest fresh weight followed by treatments EC6 and EC11 (Table 8). Significant enhancement in fresh weight of all treatments were observed over control except water, where treatment EC6 showed the highest fresh weight after one month of storage. During the 4 months of storage, dry weight of treatments EC6 and EC11 increased significantly over other treatments and noticeably treatment EC6 showed highest value. After 6 months of storage a significant array for all the treatments over control was observed except water treatment, whereas treatment EC6 showed the utmost outcome.

Table 1. Evaluation of germination % after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	83.94	70.23	57.26	47.01
Water	83.95	70.35	57.58	51.06
Salt	84.46	75.73	62.73	51.07
EC 6	85.95	74.76	60.33	56.18
EC 11	85.20	75.73	61.18	54.65
Mean	84.70	73.36	59.82	52.00
SE (m)±	0.93	1.36	0.38	0.80
CD at 5%	2.78	4.07	1.13	2.39

Table 2. Evaluation of speed of germination after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	2.82	2.71	2.50	2.17
Water	3.02	2.62	2.47	2.20
Salt	3.25	2.93	2.55	2.22
EC 6	3.33	3.04	2.66	2.27
EC 11	3.29	2.96	2.62	2.26
Mean	3.14	2.85	2.56	2.22
SE (m)±	0.02	0.02	0.01	0.02
CD at 5%	0.059	0.059	0.029	0.059

Table 3. Evaluation of first count % after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	68.17	59.89	57.42	54.33
Water	68.11	59.22	56.80	55.52
Salt	68.29	63.80	59.19	58.06
EC 6	72.32	64.53	59.68	59.35
EC 11	71.40	63.26	59.03	58.05
Mean	69.66	62.14	58.42	57.2
SE (m)±	1.07	0.83	0.60	0.40
CD at 5%	3.20	2.48	1.79	1.19

Table 4. Evaluation of average length of root (cm) after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	14.87	12.33	11.87	7.4
Water	14.93	11	10.33	7.23
Salt	15.33	12.63	12.03	8.07
EC 6	15.57	12.3	12.13	8.23
EC 11	15.37	12.5	11.97	8.03
Mean	15.21	12.15	11.67	7.79
SE (m)±	0.10	0.15	0.19	0.09
CD at 5%	0.29	0.44	0.56	0.26

Table 5. Evaluation of average length of shoot (cm) after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	11.57	11.27	9.57	5.73
Water	11.63	10.6	8.87	5.5
Salt	11.9	13.13	10	6.43
EC 6	12.47	13.20	10.1	6.63
EC 11	12.43	13.17	9.83	6.47
Mean	12.00	12.27	9.67	6.15
SE (m)±	0.32	0.20	0.23	0.11
CD at 5%	0.95	0.59	0.68	0.32

Table 6. Evaluation of vigour index after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	2559	2360.25	1506.25	696
Water	2647.25	2414.75	1356.5	761.5
Salt	2705	2426.5	1652.25	868
EC 6	2782	2447.75	1748.25	1019
EC 11	2754.75	2430.5	1663.5	958.5
Mean	2689.6	2415.95	1585.35	860.6
SE (m)±	25.71	3.70	20.61	18.29
CD at 5%	76.87	11.06	61.62	54.69

Table 7. Evaluation of fresh weight of seedling after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	1.35	1.30	1.14	0.73
Water	1.35	1.2	1.12	0.77
Salt	1.48	1.29	1.21	0.82
EC 6	1.51	1.31	1.21	0.84
EC 11	1.49	1.3	1.19	0.82
Mean	1.44	1.28	1.17	0.79
SE (m)±	0.03	0.02	0.01	0.01
CD at 5%	0.089	0.059	0.04	0.029

Table 8. Evaluation of dry weight of seedling after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	260.5	257	212.5	161
Water	259	254.5	212	159.5
Salt	268	264	214.5	173
EC 6	266.5	266.5	224.25	176.2
EC 11	264.25	263.5	221.5	175
Mean	263.65	261.1	216.95	168.9
SE (m)±	3.19	1.19	1.52	2.69
CD at 5%	9.54	3.56	4.54	8.04

Table 9. Evaluation of electric conductivity after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	234.25	250.35	330.33	337.7
Water	231.25	255	273.43	279.5
Salt	205	230.65	266.75	277.5
EC 6	198	221	249.53	265
EC 11	199	225.7	262.75	275
Mean	213.5	236.05	276.56	287
SE (m)±	0.77	0.37	0.79	1.17
CD at 5%	2.30	1.10	2.36	3.50

Table 10. Estimation of peroxidase activity in seed after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	0.70	0.43	0.36	0.28
Water	0.72	0.52	0.35	0.29
Salt	0.72	0.62	0.45	0.34
EC 6	0.77	0.63	0.45	0.39
EC 11	0.75	0.61	0.43	0.36
Mean	0.73	0.56	0.41	0.33
SE (m)±	0.004	0.011	0.009	0.003
CD at 5%	0.0119	0.032	0.026	0.008

Table 11. Estimation of á- amylase activity in seed after 24 hours after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	164.72	140.51	122.38	112.71
Water	169.1	156.56	139.90	131.81
Salt	178.21	156.96	140.24	134.49
EC 6	226.33	189.57	183.18	162.41
EC 11	205.13	185.023	180.35	155.89
Mean	188.70	165.72	153.21	139.46
SE (m)±	1.13	0.16	0.11	0.11
CD at 5%	3.378	0.478	0.328	0.328

Table 12. Estimation of á- amylase activity in seed after 72 hours after harvest

Treatments	Immediate	1 month	4 month	6 month
Control	361.38	309.41	281.32	257.26
Water	372.27	314.19	282.70	264.65
Salt	397.60	330.95	299.55	281.38
EC 6	440.7	399.91	377.40	326.57
EC 11	411.82	382.3	328.01	311.49
Mean	396.75	347.35	313.80	288.27
SE (m)±	0.11	0.35	11.18	0.10
CD at 5%	0.32	1.04	33.43	0.29

Due to maintaining the normal storage condition in all cases, the seeds existed in equal micro-atmospheric conditions. Therefore, the studies on various seedling parameters are now crucial and mainly linked with the seedling quality for early establishment of the crop and crop quality liable for grain filling. Most of the treatments showed a significant effect (Table 1-8) on germination parameters, root-shoot length, vigour index, fresh weight and dry weight under different treatments over control. The same inclination was observed in treatments EC6, EC11 and salt for seedling growth and in mass accumulation. Significant superior value was always reflected by electric stimulus though the salt and water were also maintaining a significant distinction over control in most cases. Sometimes the lower dose and water spray are not showing a significant tendency. The effect of both electric and salt treatments retained likeness in most cases where water showed a significant downward outcome, particularly with the treatment EC6. Therefore, a critical observation of biochemical activity was very essential, particularly on rainfed wheat genotypes.

Significantly decrease in electric conductivity was observed in treatments EC6, EC11 and salt over control and water treatments in immediately harvested seeds (Table 9). In the 1 and 4 months of storage, the E.C. showed same trend i.e. control maintained a significant difference with respect to other treatments though water treatment showed the highest result after 1 month. The lowest result was displayed in treatment EC6. The treatments of water, salt and EC11 were indicating an insignificant difference among them but they were significantly superior to treatment EC6 and inferior to the control after 6 months of storage. The estimation of Electrical Conductivity (E.C.) of stored seed was the easiest method for evaluation of seed quality. Seeds of lower vigour leach out a greater quantity of solutes and it would show a higher value of E.C. The increasing E.C. due to aging showed a significant negative correlation with vigour index and germination (Thakur *et al.,* 2005; Zhang *et al.,* 2021).

In immediately harvested seed, treatment EC6 significantly increased peroxidase activity over control followed by treatments EC11, salt and water respectively (Table 10). This pattern was same in one month and 4 months of seed storage, where electric stimulus and salt treatments maintained a non-significant divergence within them but significant with the other treatments. It was observed that peroxidase activity in the seed was much higher in treatments EC6 than EC11 followed by salt treatment. Although after 6 months peroxidase activity enhanced significantly in treatment EC6 over all other treatments. Among the different storage periods, peroxidase activity slowly declined but it was always higher in treatment EC6 irrespective to storage periods of seed. The biochemical nature i.e. peroxidase activity was increased by electric stimulus corroborates the work of Pati *et al.* (2007) which has an indispensable role in preventing the accumulation of H_2O_2 in addition to the buildup the tolerance against stress.

A significant increase in á-Amylase activity at 24 hours was observed in all treatments over control for immediate harvested seeds (Table 11). The highest place was achieved by treatment EC6 followed by treatments EC11, salt, water and control. This trend of á-Amylase activities was followed by seeds after one, 4 and 6 months of storage, where most of the treatments maintained a clear significant difference. The electric treatments always showed a higher result and the control maintained the lowest value.

Treatment EC6 enhanced á-Amylase activity significantly at 72 hours for immediately harvested seeds over all treatments (Table 12). After 1 month of storage treatment EC6 maintained a significantly increased value followed by treatments EC11, salt respectively over control. Seeds stored for 4 months were exhibited significant increase in á-Amylase activity at 72 hours in treatment EC6 over all other treatments. There was no significant difference found between control, water and salt treatments. In the 6 months of storage significantly highest á-Amylase activity was observed in treatment EC6 followed by treatments EC11, salt and water treatments over control. The activity of á-amylase increased with the progress of germination. The equivalent scenario was observed in the present investigation where the highest result was found in Electrotherapy in every stage of storage. Actually, the application of electric potential increased the glucose 6 phosphate dehydrogenase (G-6-PD) activity in the shoot apex of the spinach plant (Montavon *et al.,* 1987).

Priming is the foremost influencing treatment of seed for better crop growth under normal and stressful situations, particularly under rainfed conditions. From the above study it can be inferred that, electrotherapy especially treatment EC6 followed by EC11 and salt priming treatment on pre-sown soaked seed significantly enhanced the germination and biochemical parameters by establishing a vigorous seedling within a stipulated time and finally in mass accumulation. Cellular protein denaturation and loss of membrane integrity are the major factors responsible for dehydration injury to plants under water deficit. The gain of healthy seedlings at the initial stage and their proper establishment is one of the key factors playing a significant role in the production system. Hence, seed treated with an electric stimulus and salt priming for a predetermined time influenced the role of physiological and biochemical activities that leads to enhanced growth of seedlings.

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