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BIO MOLECULAR CHARACTERIZATION OF IMPACT OF WEAK ELECTRIC FIELD ON THE PLANT SYSTEM

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ABSTRACT

Because of the important role of plants on earth environment and life, the study of the factors affecting the growth, conservation and use of plants is essential. The emerging activities of bio molecules to enhance the plant growth under electric control have already been reported. The factors like temperature, soil conditions, atmosphere etc are common to affect the plant systems. The effect of varying as well as static electromagnetic field on seed germination and growth of plants has been found significant. On the other hand the effect of external electric field on the seed quality and sprout growing was studied and its impact was reported. The present study deals with the effect of weak electric field on plant systems like Gram, Maize and wheat which are agriculturally important in India. The seeds of the above mentioned plants were pre soaked for 24 hours in normal water and the external field producing currents of 20 mA was passed in the seeds of Gram, Maize and wheat already kept in conducting incubator for 2, 4 and 6 hours. The germination rate and morphological growth in treated condition have been observed for thirty days in comparison to control condition. The pattern of starch and reducing sugars contents in the samples has been examined and attempts have been made to find the path way of the impact of electric field by the study of the protein and DNA profiling of the samples under investigation.

KEYWORDS : *Brassica napus*, Morphological, *Phaseolus vulgaris*, Electromagnetic

The plants have been observed to be active on electric as well as magnetic field and subsequent effects of electric and magnetic fields on the plant growth have attracted the attention of scientists significantly engaged in inter-disciplinary research. Previously, many scientists believed that the electromagnetic field was not biologically active but the recent results reported by various researchers have revealed the interesting impact of electromagnetic field on biological systems. The effect of AC & DC magnetic field on germination rate of seeds in *Brassica napus* L plant was studied and it was reported that the impact was not significant; however, the growth of seedlings was reported to be affected with different exposure time (Majid et. al. 2009). The effect of static electromagnetic field on the seed germination in Rose coco beans (*Phaseolus vulgaris* L) was studied and it was reported that the rate of germination was increased under the exposure of static electromagnetic field (Odhiambo et. al, 2009). Influence of electric field on the quality of flax seed was observed to be positive and the quality of the seed exposed under electric field period was reported to be better in comparison to control (Pozeliene, 2000). The enhancement in Bean sprout growing due to the expedient exposure of external electric field on seed before plantation was reported (Kiatgamjorn, 2002). The germination rate of Gram seed was observed to be augmented if the seeds were well exposed with the electromagnetic field of suitable strength and beyond an optimum value of electric field the germination rate was observed to be declined in comparison to control (Das and Bhattacharya, 2010). The impact of electric current on morphological growth of the various plants has been found significant for 20 ma current (Mishra and Tiwari, 2011). The electric field in positive control has also been observed to enhance the graft compatibility in plants employed for getting good yields (Mishra et al, 2010). All the mentioned researches deal with the morphological study of the plants under various electromagnetic treatments and justify the hormones activity in the root and meristems overall.

The present study examines the pattern of variation of biochemical namely starch and sugar contents in plant systems under weak electric control condition and subsequent biochemical pathway responsible for the morphological changes occurred due to impact of weak electric field on the germination of seeds and plant growth. The Protein and DNA which are one of the important bio molecules responsible for carrying out the path way for the plants growth, were extracted from the plants both in treated as well as control conditions and their profiling has been examined to link the conformational changes in Protein profiling.

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MATERIALS AND METHODS

The seeds of gram, wheat and maize plants were pre soaked for 24 hours and six samples containing 50 seeds were made for each plant. The DC currents of magnitudes 10 mA, 20 mA and 30 mA were passed in the five samples of each plants kept in conducting incubator for 2, 4 and 6 hours. The sixth sample of each plant was taken without treatment for control condition. The rate of germination was recorded for each sample in comparison to control. The maximum percentage of germination was observed for 20 mA treatment condition. Thereafter, the current of magnitude 20 mA was passed in the fresh sample of seeds pre soaked for 24 hours of each plant for different periods like 2, 4 and 6 hours in order to examine the time dependency of the impact of the current on seed germination and plant growth. The seeds were then kept for growing the plant in normal laboratory condition for 30 days by supplying Hoagland solution as the nutrients. The various morphological parameters like plant length, inter nodal distance, dry weight and fresh weight were measured during the course of the development of the plants.

Starch and Sugar Estimation

For estimation of sugar and starch, plant material was fixed in boiling 80% ethanol in the proportion of 1:10 alcohol soluble and insoluble fractions were separated by repeated centrifugation. in the alcohol soluble fraction,sugars were estimated while alcohol insoluble fraction was used for the determination of starch. Sugars were determined colorimetrically at 500 nm by the method of Nelson (1944). Total reducing and non reducing sugars were estimated as reducing sugars (using invertase) for 24 hours the non reducing sugars were calculated as the difference in the concentration of sugars before e after hydrolysis by invertase .

Starch was estimated by the method of Montogomery (1957). The alcohol insoluble materials were first made soluble in distilled water kept in a boiling water bath and was extracted in 25% per chloric acid (pca). After repeated extraction in pca to a suitable aliquot, the supernatant was added 80% phenol. This was followed by rapid addition of concentrated Sulphuric acid. The solution was allowed to cool at room temperature and the color developed was read at 490 nm

Protein and DNA estimation

The protein and DNA molecules were extracted from the leaves of plants of each sample including the sample in control as per available methods. The optical density of proteins extracted from each sample was determined with the help of spectrophotometer operated for 595 nm wavelength. The profiling of proteins in each sample was studied by taking emission spectra in Sodium Dodecyl Sulphate (SDS) electrophoresis and Photoluminescence Meter made by Perkin Elmer model LS 55. The DNA profiling of each sample was studied by taking the emission spectra in 1XTris EDTA (Ethyl Diamene Tetra Acetic Acid) electrophoresis and by Photoluminescence Meter made by Perkin Elmer model LS 55. The data of starch and sugar estimation and subsequent bio molecular characterization using protein and DNA profiling for gram plant have been depicted in the results as the same trends were observed in other plants.

RESULTS AND DISCUSSIONS

The amount of total sugar has been observed to be increasing significantly in gram and maize plant given electric treatment. The increase was most pronounced at 4

Table 1: Total Sugar:%Fresh Weight

Seed of Plant	Control	2 hours treatment	4 hours treatment	6 hours treatment
Gram	0. 080	0.170	0.365	0.248
Maize	0.625	0.753	0.890	1.165
Wheat	0.253	0.290	0.180	0.138

Table 2: Reducing Sugar:% Fresh Weight

Seed of Plant	Control	2 hours treatment	4 hours treatment	6 hours treatment
Gram	0.037	0.105	0.159	0.103
Maize	0.251	0.326	0.428	0.425
Wheat	0.166	0.145	0.068	0.081

Table 3: Starch:%Fresh Weight

Seed of Plant	Control	2 hours treatment	4 hours treatment	6 hours treatment
Gram	0.0294	0.0366	0.0626	0.0418
Maize	0.0731	0.0844	0.0855	0.1305
Wheat	0.0945	0.0993	0.1177	0.1293

OPTICAL DENSITY DATA (At 595 nm wavelength with the help of spectrophotometer).

SAMPLE	OPTICAL DENSITY
Pure Bradford solution	0.725
Control	1.282
2 hrs. treatment	1.029
4 hrs. treatment	1.002

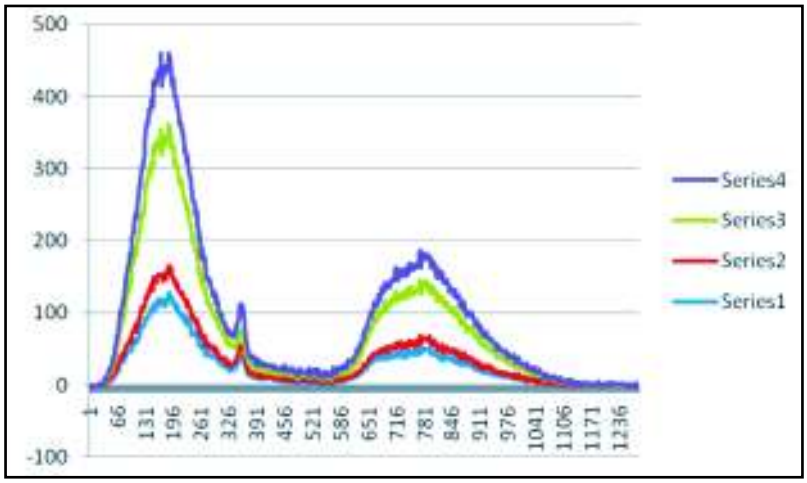

Figure 1: Emission spectra of proteins extracted from gram plant in control, 2, 4 and 6 hours treatment with external electric current of 20 mA taken by Photoluminescence Meter made by Perkin Elmer model LS 55 with (240-260)nm wavelength.

hours treated gram plant and 6 hours treated maize plant. Contrary to gram and maize plants, wheat plant showed decrease in total sugar at all treatment except 2 hours treatment. Almost same trends were observed for reducing sugars plant in all the three plant species under investigation.

The amount of starch increased significantly at all stages of treatment in all the plants under investigation. The increase was pronounced at 6 hours treatment except for the gram plant which showed maximum increase at 4 hours (table1).

The present investigation envisages that the weak electric control favors the plant growth in accordance with other results (Mishra & Tiwari, 2010, Mishra & Tiwari, 2011). The relative optical density of protein obtained with the help of Spectrophotometer exhibits the decrease in its concentration (table 4) and the same is supported by the emission spectra obtained through SDS electrophoresis and Photoluminescence meter (figure 1 & 2). It appears that conformational changes take place in protein profiling due to the impact of the external electric current. The type of protein and its bio molecular characteristics evolve due to conformational changes needs further study for its identification. No significant change was observed in DNA profiling. It appears that DNA profiling is not affected significantly due to the impact of weak external electric current as its frequency is infinitely large.

CONCLUSIONS

Carbohydrates are essential component of all living organism and are, in fact, the most abundant class biological molecules (Voet & Voet, 2004). Sugars are a class of edible crystalline carbohydrates, mainly glucose, fructose and sucrose characterized by a sweet flavor

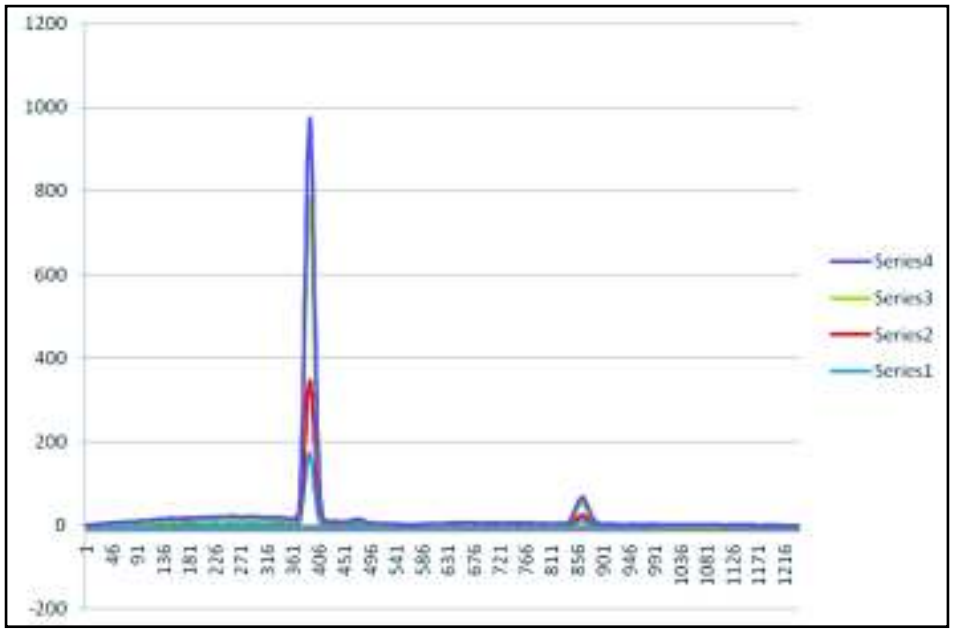

Figure 2: Emission spectra of DNA extracted from gram plant in control, 2, 4and 6 hours treatment with external electric current of 20 mA taken by Photoluminescence Meter made by Perkin Elmer model LS 55 with 280 nm wavelength.

(IUPAC gold book, 2009)..

Sugars are categorized in to reducing and non reducing types.sugars are saccharides bearing anomeric carbon atom that have not formed glycosides are termed reducing sugars because of facility with which the aldehyde group reduces the mild oxidizing group (Voet & Voet, 2004). Examples of reducing monosaccharides includes glcose, fructose, glyceraldehydes and glactose. Many disccharides like lactose and maltose also have a reducing form as one of the two units may have an open-chain with aldehyde group of plant, particularly leaves. Glucose is converted in to sucrose before being translocated to other plant parts like stem, roots etc. Increase in reducing sugars under electric treatment might be a result of enhanced photosynthesis .This might be possible by regulation of enzyme of photosynthetic pathways. When sugars react with other molecules in such a way that their anomeric carbon hydroxyl form the linkage, then that sugar becomes a non reducing sugar e.g. Sucrose & Trehaloses.

The glucose is the most important reducing sugar in higher plants synthesized by the process of photosynthesis that takes place in green plant.

The increase in total sugar content may be probably due to increased rate of conversion of glucose in to sucrose for being transported to other parts.

Starch is a polymer of glucose that plant synthesizes as their principal food reserves (Voet & Voet, 2004). Increased starch content under treatment again suggests enhanced conversion of photosynthetic product, glucose in reserve food i.e. starch.

The impact of external electric field on plant growth has been observed to be transient phenomenon and establishes inter cellular communication for the flow of minerals, water etc supporting the plant growth (Mishra & Tiwari, 2011). The electrical signaling has been found to be good means for early detection of the plant growth in terms of inter cellular communication (Mishra & Tiwari, 2012). The cellular communication responsible for the hormonal growth appears to be oriented in different directions in the plants under control condition (Mishra et al, 2010). The weak external electric field channelizes the cellular communication and enhances the hormonal signaling in the seed ready for germination. The impact of external electric current on seed germination and plant growth has been observed to be time dependent and it continues to be positive till exposure period not more than four hours. The positive impact is distorted when exposure period exceeds. It appears that the strong electric field distorts the inter

cellular communication and compatibility of plants with the environment.

The present study suggests a way of getting enhanced growth in seed germination and plant morphology in agriculturally important plants. The technique may also be exploited to enhance the growth rate of plants, which are medicinally important but not easily germinating and fast growing. The present study is a significant contribution in the area of large-scale production of medicinal and aromatic plants as well as in forestry production.

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