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ELECTRICAL AUGMENTATION OF SEED GERMINATION IN CHICK PEA

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Abstract

A lot of researches have been carried out on the positive effects of direct electric current on yield and germination of seeds from different plant. Electric current defines various physiological changes in seeds, resulting to faster water absorption and retention, and respiration in germinating seeds. In this research it was found that 24 h of direct electric current of the range of mili-ampere augments the induction of seed germination in chick pea. It was also found after the appearance of plumule, that the root and shoot growth were reasonably faster in case of electrically treated seeds. Further, it was established that in electrically treated seeds the reducing sugars were present whereas it was absent in control samples and protein content was approximately doubled in electrically treated samples.

Key words: Chickpea (*Cicer arietinum* L.). germination in chick pea.

Introduction

Chickpea (*Cicer arietinum* L.) is amongst the important legumes cultivated worldwide and is a self pollinated crop (Singh, 1997; Abbo *et al.*, 2000). The productivity of a crop may be increased to some extent, if its germination rate is enhanced. Seed germination represents one of the most critical stage in the life cycle of any plant. In water scarce area the seed germination is always difficult as the availability of water for complete imbibitions of seeds may not be available. Seed germination can be improved/enhanced by seed priming (Musa *et al.*, 2001; Sori, 2014), seed soaking in water with porous material (Ghana and William, 2003), humidification (Van Pijlen *et al.*, 1996) and with the use of external EMF (Rajendra *et al.*, 2004; Mishra, 2015). Out of all these methods, external EMF application becomes more considerable because it offers engineering and nucleic acids are affected by magnetic fields. It has been shown that electric current in the range of 1-5 µAmp is capable of influencing the increase in volume/cell size for achieving increased better growth of plant tissues (Sahai and Dutta, 2007). The cellular response generated by EMFs application is actually a protective mechanism and may be responsible for the expression of stress regulated genes (Ruediger, 2009). Effect of magnetic field has been observed on chick pea (Mahajan and Pandey, 2012) and significant alteration in root length of chick pea was obtained when low strength magnetic field was applied in defined time frame (Vashisth and Nagarajan, 2010). The existing records strengthen the hypothesis that EMFs application during seed germination is responsible for various bio-physiological changes associated with plant growth machinary and is an indicative of quicker water assimilation, better seed breathing, intensification of photosynthesis in seeds etc. (Podlesny *et al.*, 2004). The current study was undertaken in order to evaluate the positive/negative aspect of electric field application on the germination of presoaked seeds with respect to strength and exposure time.

Materials and methods

Procurement of chickpea seeds and imbibition

Dried chickpea (*Cicer arietinum* L.) seeds were collected from IARI, New Delhi, India. The collected

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seeds were washed thrice with sterile double distilled water in order to remove soil and other impurities associated with the seeds. This was followed by soaking of the washed seeds in distilled water for 2h for imbibition purpose. The seeds were furthur transferred to a fresh beaker containing 100 ml of sterile double distilled water.

Application of electric field to imbibed seeds

Twenty chickpea seeds were placed in the beaker in the previous step and two electrodes facing each other were fitted into it. The electrodes were connected to an AA battery (1.5V) with the help of alligator clamps (Dutta, 1996; Sahai and Dutta, 2007). The experimental seeds were left exposed to the weak electric field for 24 h. After the defined duration of one day, the seeds were extracted with the help of a sterile forceps, transferred to aluminium foil conatining moist cotton and exposed to low sun rays. The aluminium foil containing seeds was monitored at a regular interval of 2h and were moisturised whenever needed. The experimental set was accompained by a control set for which the electrodes were not connected to the current supply (AA battery, 1.5 V).

Quantitaive test for carbohydrate and proteins

A quantitative test for carbohydrate was performed through Fehling's test and quantitative determination of protein was done by Lowry's method. and the optical density measurements were done at 720 nm.

Result and Discussion

Initiation of radicle and plumule after electric field application in imbibed seeds

There was a significant difference between the germination of control and the experimental seeds. In the control seeds, root development was visible but no shoot was formed in the first 24 h whereas in the electrically treated seeds both the roots and shoots were developed vigorously within 24 h of the electric treatment (fig. 1). The control set showed the protruding plumule only after 96 h.

Formation of Roots on the developing shoots

The roots initiation was observed in both the treated as well as the control set of seeds but the extent of root development was more in the electrically treated set as compared to that of control (fig. 2). The germinated electric stressed seeds produce 6-15 roots/shoot while the control seeds harbour 3-5 roots/shoot.

Estimation of carbohydrates and proteins

The presence of reducing sugar was confirmed in the experimental set of seeds by the appearance of red ppt., while the control set produced a black precipitation (fig. 3). The obtained result indicates that the optical density was following an increasing trend. The calculation of protein samples for an experiment conducted herewith was verified by the standard procedure of Lowry's method. The values obtained were 591 $\mu g ml^{-1}$ for the control seeds and 1060 $\mu g ml^{-1}$ for the experimental seeds. It shows that the substantial increase in protein content is more or less double in the electrically treated seedlings in comparison to untreated seedlings.

Discussion

Germination depends on many physiological factors such as temperature, water potential, light nutrients and smoke. Temperature plays a crucial role in seed germination rate and its dormancy. From the earlier times living organisms have been exposed to natural EMF (electromotive force) of the earth. In comparison to the

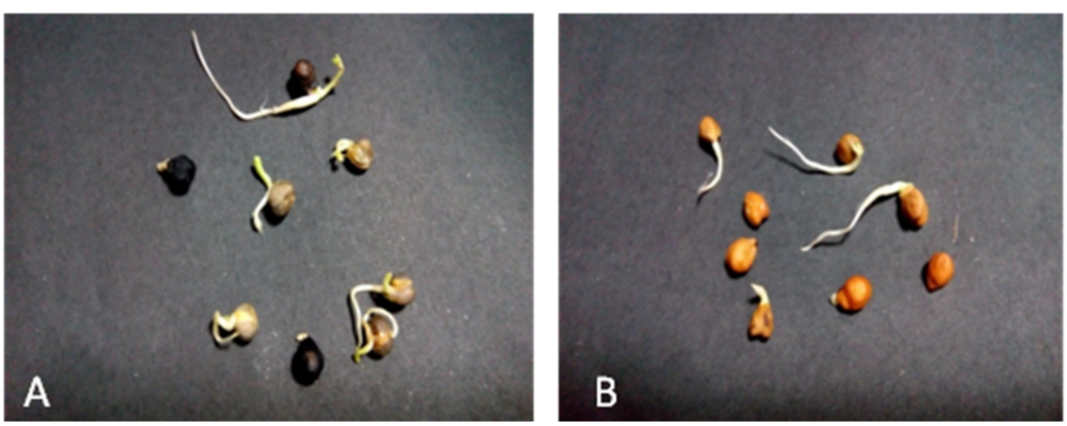

Fig. 1: Initiation of radicle and plumule in experimental (A) and control seeds (B) of chickpea after 24 h of electric treatment. The experimental seeds (A) showed root and shoot formation within 24 hrs in the beaker supplemented with wet cotton while the control seeds (B) germinated with only radicle. However, the electrically stressed seeds turned black in colour in contrast with the control which appears in its normal colour.

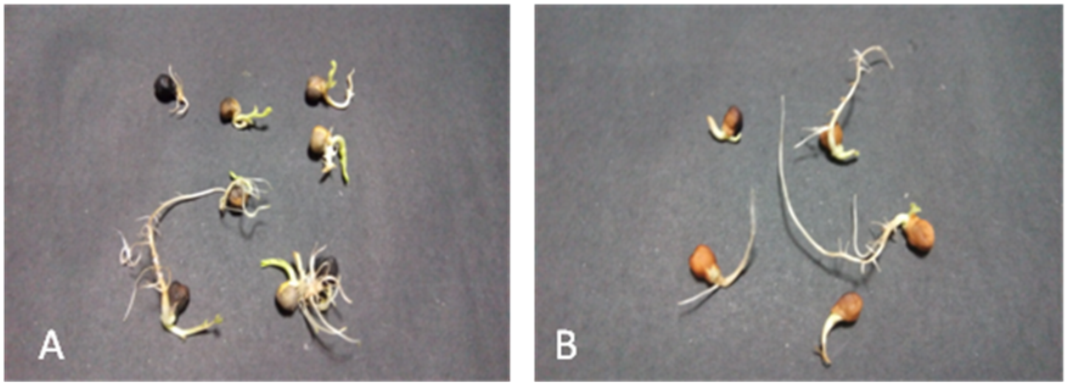

Fig. 2: Formation of root in experimental (A) and control seeds (B) of chickpea after 96 h of electric treatment. The experimental seeds showed profuse rooting while the control seeds showed few developing roots.

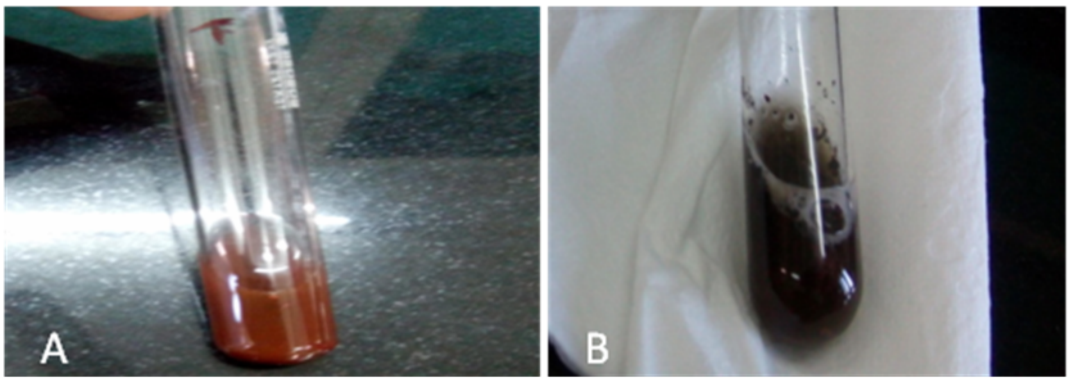

Fig. 3: Red precipitation on Fehling's test on the experimental sample (A) shows the presence of reducing sugar whereas the control sample (B) gave a black precipitation.

control seeds, the imbibed chick pea seeds which were exposed under electric field were found to be positive and showed better response. It proves that electric current has a positive influence on the germination and the growth of the gram seeds and is supported by the study of increase in morphological growth of plants on application of electric field (Mishra *et al.*, 2010). Small and direct current is capable of enhancing plant growth and cellular elongation (Sahai and Dutta, 1997; Golshani and Asgharipour, 2014) and it has been also estblished that weak DC electric field has got effect on the developemnt of root meristem (Wawrecki and Zagorska, 2007). The result obtained in our study for the root formation in experimental set and control is supported by the previous experiments of the workers and it can be deduced that the application of weak DC current can have a influence on the growth pattern of roots. The presence of reducing and non-reducing sugar is also influenced by applied electric field (Mishra *et al.*, 2015; Dutta, 1996). Our results indictes that the presence of reducing sugar is enhanced in the electrically treated seed set and is in conformation with the earlier result. The optical density for protein estimation by lowry's method obtained was almost double in experimental as compared to the control sample and that may be due to may be due to stress. The result obtained for protein estimation is suggstive of the impact offered due to external electric field and is also important for assessment of conformational changes in protein profiling (Mishra *et al.*, 2015; Dutta, 1997). The results obtained in our result if clubbed with the previous reports can deduce that the involvement of electric current supports profusive root growth and is capbale of altering protein biosynthesis, enzyme activity, gene expression, cell reproduction and cellular metabolism (Souda *et al.*, 1990; Pietruszewski *et al.*, 2007; Florez *et al.*, 2005; Florez *et al.*, 2007; Mahajan and Pandey, 2014; Shabrangi *et al.,* 2011; Molamofrada *et al.,* 2013). Thus, an interesting approach towards cell growth enhancement is possible by using the application of magnetic fiels and electric field specially in slow or difficult germinating plants.

Conclusion

With this research it was estabilshed that the direct electric current helps in augmenting the seed germination manifold in chick pea. Further, the experiment determines the role of increased germination with physiological changes like formation of reducing sugars and increased protein content in electrically treated seeds.

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Authors contribution

HU and PS conducted the experiments; RD planned the work and inferred the results; VBS helped in inference of results and drafted the manuscript.

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