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EFFECT OF ELECTROCULTURE ON PLANTS - A REVIEW

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Abstract-Wide range of experiments was done to study effect of electroculture and externally applied electric and magnetic field on crop plants. Frome ancient time to modern technologies has been invented different methods for application of electric field and researches on this field was enhanced. This paper highlights the experiment and techniques used in electroculture.

Key words- Electroculture, Electric field, Magnetic field, plant growth, Germination.

Introduction- Electroculture is a group of technique that is used electricity to increase the growth and yield of crop plants. It is the field that use electricity, electric field and electric current to plant development. The word electroculture means electric way of life. Abbe Nollette (1746) was the first researcher who was noted effect of electricity on plants. Due to application of electricity the plant growth and fertility was increase noted by Bertholon (1783).

Ross (1844) he uses copper rod and galvanic cell for application of electricity and obtain increased growth and yield of potato. According to Solly (1845) the earliest work on the electroculture was done by Mr. Memibray of Edinburgh they electrified two myrtles and found electrified myrtles increase in length and bloom early than non-electrified myrtles. Elfving (1882) studied the root of seedling curve towards the positive pole when it places between two electrodes. At that time series of experiments

with different crops was carried out by many researchers by using electrodes such as Solly 1845, Paulin 1892, Woolly 1893.) Holdelleiss (1885) use copper electrodes in field and obtain 15 to 20 percent increase in yield of Sugar beets and potato. The application of electricity to plants with soil current increase in the fresh weight of plants reported by Bertholon (1889).

Lemstrom (1904) set a number of experiments to study effect of electric current on crop plant and he obtain increase in growth and yield of various crop plants due to application of positively charged electric current. Such type of results noted by Lodge and Newman (1915) they use an apparatus made Frome induction coil on agricultural field and get increase in yield of crop plant. Not only weight of plant was increase but the signalling and stimulation was also increase in leaf of *Mimosa* and *Desmodium* due to application of rapid and long electric currents J.C Bose (1918). Blackman V.H. et al. (1923) reported the application of weak electric current 0.5×10^{-10} amp. Increase in growth of roots due to weak current. In 1930 Homberger reported application of high-tension current with high frequency there is no harmful effect on plants application of high-tension electric spark for 5 to 10 min. on different seed varieties it shows high germination rate, better growth, increase in yield and these plants resistance to disease and pest it also energizes the soil. Smith et al. (1933) exposed the seed of radish to 60 Hz electric fields and found seed was significantly delayed seed germination followed by rapid growth to increase plants height and weight. Application of electric current not only effect on germination and growth but it also increases the uptake of minerals in plant Ward (1936) reported that direct electric current treatment on Tomato plant that grown hydroponically with electrodes increase dry weight and improve uptake of magnesium, calcium, and nitrogen. Dorchester C S (1937) found that application of electric current on certain crop plant like corn, soyabean, beets, string beans, oats increase in the number of grains and length of straw. Application of electric field significantly increase in yield of Radish and Lettuce the yield was increases up to 22 to 58 percent after treatment with 0.2 to 0.4 mA electric current.

(Stone 1904 and Dorchester 1937). Lakhovsky (1939) use different oscillator circuit, one turn copper coil for application of electric current and the current produced by oscillating circuit at the time of application it is beneficial to crop plants. The techniques of electroculture were well known discovered by researcher Christoffleau (1993) he devoted years of research for development of electroculture techniques and he get remarkable results in Oats, Potato, Beet root etc.

The pre-treatment of seed with electric current also increase the seed germination Bobryshev et al. (2000) found that electromagnetic field application before the sowing period of 7-20 days stimulates the seed germination of a pea, barley, and Wheat. Electricity with different intensities effect on plant growth Rotchareon T et al. (2002) reported application of electric field with the 193 kv/m and the 4 Kv/m intensity significantly affect the growth and height of a rice plant. This type of result also reported by Chakravarty M and Sadhu M (2003) apply different electric fields with 0, 3, 8, 10, 12, 15, 20, and 25 v/m and observe electric fields stimulate germination and seedling growth of okra, radish, and jute. Antonova G (2004) studied Pre-sowing treatment of head cabbage with AC corona discharge field it increases weight and yield Significantly. Electricity not only effect on seed germination it also effects of growth parameters, yield parameters and phenolic components of plants. Ye Hong et al. (2004) investigated electric field (50 Hz, 10 v/m) increase reactive oxygen species and phenolic compounds in *Taxus chinensis*. It also reported by Costanzo E. (2008) apply 3600 and 1800 v/m AC electric current on soy seedling and obtain increase in length of seedling up to 8 to 12 percent. Proline accumulation was induced by the application of electric field Verbrugren N and Hermans C (2008). The cell proliferation and synthesis of DNA and RNA significantly affected by application of electricity Ruediger HW (2009). Vashisth A et al. (2010) exposed Sunflower to static magnetic field 0 to 250 mT for 1 to 4 h and concluded that treated seeds significantly increased dry weight, root length, root surface area and root volume, it also increased enzyme activity in germinating Seed.

Imbrea F et al. (2011) found that Pre-sowing treatment of maize with low frequency electromagnetic waves (22Hz, 22.5Hz, 23Hz, 23.5Hz, 24mT.) increases lipid, raw fiber, carbohydrates, carotenoids, and chlorophyll in the maize leaf. The Highest lipid, Protein, and Fiber observed at (24Hz). It indicate that application of electricity to pre sowing seeds not only increase the germination rate but it also increases nutrients present in it. The chromosomal aberration also affected by electricity Racuciu M. (2011) found that treatment of maize seed with electromagnetic field of 50Hz and 10 mT induced chromosomal aberration in germinating Maize seed lower than 1%. Application of DC electric field on Daiken radish it improved the germination rate and increased the length and weight of radish. It improves the water absorption and accelerated stem elongation reported by Okumara et al. (2012). Mahommad M et al. (2013) reported Electromagnetic field of 275 kV high voltage change protein content and protein bending in oil palm. The growth rate of plants also affected by the positive intensity of electric field. Increase in intensity of electric field it decreases the growth rate of plants M. E Maffei (2014). Farzpourmachiani S. et al. (2015) found that application of electric current and magnetic field increases in the yield of crop plant it also reported by several researchers such as Dayal et al (1983), Antonova G et al. (2004), Lakshmapa et al (2011), Radhakrishnan et al. (2012), Ahmad et al (2015). Nitrogen uptake of plant was increase due to application of electricity Yanyou Wu et al., (2016) found that application of High-voltage electrostatic field increase nitrogen uptake in cucumber Plant. Electric field at 10 kVcm⁻¹ Significantly increase the inorganic nitrogen uptake.) . Application of electromagnetic field of 50, 100, 150, 200 And 250 mT for 1, 2, 3 and 4 h. on maize increases the percentage germination, speed of germination, length of seedling, and weight of maize Seeds. It increased shoot length, number of leave, chlorophyll Content, shoot and root weight and it also improve root system. It also increased yield of maize investigated by Vashisth et al., (2017). In 2018 Patil M. B. reported application of 3V, 6V, and 9V electricity on *Raphanus sativus L.* has shown significant effect on seed germination and growth of (*Raphanus sativus L.*). Reyes E.M. et al. (2019) studied effect

geographical, climatic and edaphic condition. There is need to conduct these experiment worlds wide.

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of electroculture techniques on vegetables like tomatoes, eggplant, broccoli, peppers, reported that application of electricity and magnetism increased growth rate, yield and reduced the requirement of fertilizers and pesticides. It also helped plants to grow faster. This technique was proved to protect plants from diseases and insect thus lowering cost of production. Mildaziene V et al. (2020) reported pre-sowing treatment of red clover seeds with electromagnetic field resulted in increased seed germination up to 4 to 20 % and they also recorded an increase in protein per plant up to 70%.

Some researchers obtain opposite results by using electroculture technique Blackman (1924) also found similar result he found that application of electricity has no significant effect on soil nitrogen content. Birstein E et al. (1940) noted the harmful effect of Direct and alternating current on growth of Oat they used (10v, 50v, 70v, 110v, 140v) electric current and found that the DC of 0.7 micro amp. there is no change in growth seedling but it can indirectly affect on the growth hormones and pH gradients in plant. High intensity electric field significantly effect on plant growth and growth response Murr (1963). Brayman A. et al. (1990) found that exposure of maize to 60 Hz electric field inhibits the net apparent H (+) ion in the root of *Zea mays* and this electric field inhibit the root growth. Dorsey (1994) reported that application of electric field on crop plant has no effect on growth and Yield. In 2012 Liu M Y. concluded that electricity effect on plant growth. With (5, 9 and 12v DC) on lettuce seedling and found that there is no effect of electricity on plant growth. Application of a high concentration of negative ions on plant growth it influences the growth of plants while positive ions did not affect plant growth Elkley T M. et al. (1985).

Conclusion- From above review it can be concluded that application of electric and magnetic field increases the seed germination, growth parameters, phenolic content and yield parameters of crop plants but the results are varied from crop to crop. Thus, plant response to the electricity is studied since 18th century and still this work is carried out as response of the same plant are changing according to the

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