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Recent advances in plant bioelectromagnetics

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This review analyses the state-of-the-art in the field of bioelectromagnetics with respect to plant growth. The field induced had been either constant or pulsating, varying from weak to strong. This paper summarises the observations and discusses the possible mechanisms.

Key words: Plant growth, bioelectromagnetics, pulsating magnetic field

TREATMENT IN MAGNETIC FIELD

Magnetic treatment of plant materials include treatment of seeds or seedlings in pulsating or constant magnetic field of varied intensities for varied intervals of time. It is possible to grow the entire plant in desired controlled field, or in total magnetic vacuum. Water passing through magnetic field undergoes certain physical changes. Such changes enable the associated states of the monomolecules and multimolecules in water to be in an equilibrium state and produce a stable bimolecule $(H_2O)_2$. Plants when irrigated with such water have been found to grow faster with more yields.

Liquid crystals are intermediate phases between the solid and the liquid state occurring in many organic compounds. Many such crystals orientate in the fields of the order of 1000 Gauss, and it has been shown that in orientated liquid crystal systems there can be a marked change in diffusion and in rates of chemical reactions.

TRANSPORT THROUGH MEMBRANES

Membrane transport is the basic phenomenon that occurs at cellular level. The potential difference between the two sides of the membrane affects the transport of matter through the membrane. As magnetic and electrical fields are interrelated, it is possible that the potential difference between the two sides of the membrane changes.

INFLUENCE OF DIFFERENT POLES

Percentage of seed germination of red gram (*Cajanus cajan*) was found to be accelerated under the influence (south) of magnetic moment 2.7 $A.m^{-2}$. In general, the outward diffusion of cations Na^+, Ca^{++}, Mg^{++} and Zn^{++} have been found to be inhibited by both N-and S-poles, when the above seeds were soaked in distilled water [1].

Prior observations

Treatment of soaked cotton seeds with 80-400 $A.m^{-1}$ constant field for 20 min. has increased DNA, RNA, protein, ascorbic acid and peroxidase in four- day-old seedlings. The effect was highest at 2000 $A.m^{-1}$ in *Gossipium hirsutum* and at 400 $A.m^{-1}$ in G Barbedense [2]. Exposure of cereal and vegetable seeds before sowing increased the nuclear DNA and RNA of root meristem cells and increased crop yields. Maximum effect on the meristem cells has been observed in plants from seeds stored for 6 days after magnetic treatment. They were oats, barley, wheat, beets, cabbage, raddish, lettuce, carrots and tomato. 120 days-old cabbage plants grown under south pole treated seeds had higher vitamin C and B_1 when compared to plants grown from north-pole treated seeds. Static or pulsating magnetic field-treated seeds at 0.05 - 0.2 T, for 15 min. have resulted in a marked increase in the rate of respiration and germination.

At 0.1T, a four-to-five fold increase in respiration has been observed. Treatment of seeds in a nonuniform magnetic field with an intensity of 16 and 32 $KA.m^{-1}$ has resulted in larger percentage of germination and the plant grown had higher resistance to unfavourable external factors.

Magnetic treatment of irrigation water and/or seeds

Untreated corn seeds irrigated with magnetically treated water daily for 20 days resulted in increased plant weight when compared to corn seeds treated at a magnetic field of 1600 G for 10 min. or control. Treating either water only or seed only increased the auxin content by 6-fold. Treatment of both water and seeds did not have any effect above that of control [3].

MECHANISM

Broadly speaking, the enhancement of growth may be due to the structural and physicochemical changes that occur or due to the enhancement of enzymatic reactions. The orientational and translational motion of biological macromolecules, larger biological particles in dilute solution and in liquid crystal state undergo changes in

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magnetic fields [4]. Constant magnetic field has been found to affect the acid metabolism in young wheat plants, probably by the alteration of redox processes [5]. Changes in the activity of the enzymes may be explained by the effect of the field on the reactivity of the enzyme molecules and the influence of the field on the reaction catalysed, in which paramagnetic centres of the respiratory chain take part [6].

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