This article is a 'work in progress' incorporating new information whenever time permits.

Fungi, plants, trees, seeds and EMFs

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Roux (2008) found that 900 MHz RF radiation below thermal levels affected plants. When exposed, the plants initiated "self-repair" processes very similar to those expected when the plant perceives itself to be injured. Roux concluded *"Taken as a whole, the data provide new evidence supporting the hypothesis that plants perceive and respond to microwave irradiation as though it was an injurious treatment."*

Tkalec (2009) found cellular effects in germinating onions when they were exposed to 400 and 900 MHz electric fields of 41 and 120 V/m. Whilst the upper value is above ICNIRP the lower value is not, and a quite feasible field level to be received by the head when talking on a mobile phone.

Sharma (2009) concluded that mobile phone radiation inhibited root growth of mung beans by inducing ROS-generated oxidative stress despite increased activities of antioxidant enzymes. Another study by Singh (2012) confirmed that mobile phone radiation affected biochemical processes manifesting as oxidative stress which impaired root growth in mung beans.

Fungi

Electromagnetic fields were found to promote hyphal growth in Tuber borchii (Potenza 2012).

Plants

Gagliano (2012) found that seeds and seedlings of the chili plant, Capsicum annuum, are able to sense neighbours and identify relatives using alternative mechanisms beyond previously studied channels of plant communication. The authors offer a hypothetical mechanistic explanation as to how plants may do this by quantum-assisted magnetic and/or acoustic sensing and signaling.

Pulsed electromagnetic fields as a presowing treatment was found to enhance plant growth in tomato plants. Yield per plant was higher in magnetic field treatments (Efthimiadou 2014).

Seeds

Pretreatment of PMF plays important roles in improvement of crop productivity of soybean through the enhancement of protein, mineral accumulation and enzyme activities which lead to increases in growth and yield (Radhakrishnan & Ranjitha Kumari 2012). A further study by the same team found that 10 Hz PMF treatment enhanced the germination and seedling growth of soybeans (Radhakrishnan & B Kumari 2013).

Microwave pretreatment for 5 or 10 seconds conferred tolerance to cadmium stress in wheat seedlings (Qiu 2011). The results also showed that the microwave radiation had a positive physiological effect on the growth and development of cadmium stressed seedlings.

Pre-seed electromagnetic treatment has been used to minimise drought-induced adverse effects on maize (Javed 2011).

Pulsed electromagnetic fields have been found to promote germination and improve early growth characteristics of cotton seedlings. Such priming techniques are especially valuable in organic cultivation, where chemical compounds are prohibited. Magnetic field treatment of 15 minutes was found to stimulate germination percentage and to promote seeds, resulting in 85% higher values than control seeds under real field conditions. Seeds that were treated with a magnetic field performed better in terms of early-stage measurements and root characteristics (Bilalis 2012).

Germination enhancement was optimum for the mung beans exposed to 100 mW for 1 hour power-duration level, while for water convolvuluses the optimum germination power-duration level was 1 mW for 2 hours. When both seed types were exposed at the early sprouting phase with their respective optimum power-duration levels for optimum seed growth, water convolvuluses showed growth enhancement while mung bean sprouts showed no effects (Jinapang 2010). Perhaps discrepancies may be explained by the results of one experiment where the growth in mung beans exposed to low frequency EMF was inhibited at low field intensity, but was enhanced at a higher intensity (Costanzo 2011).

Fermentations of the yeast S cerevisiae with magnetic treatment reached their final stage in less time, i.e., approximately 2 hours earlier than controls (Perez 2007).

Treatment of sunflower seeds in magnetic fields increased the speed of germination, seedling length and seedling dry weight under laboratory germination tests (Vashisth & Nagarajan 2010). Exposure of seeds to magnetic fields improved seed coat membrane integrity and reduced the cellular leakage and electrical conductivity. Treated seeds planted in soil resulted in statistically higher seedling dry weight, root length, root surface area and root volume in 1-month-old seedlings. Higher enzyme activity in magnetic-field-treated sunflower seeds could be triggering the fast germination and early vigour of seedlings.

Poinapen (2013) found higher germination (~11.0%) was observed in magnetically-exposed seeds than in non-exposed ones, although seedlings emerging from static magnetic field treatments did not show a consistent increase in biomass accumulation.

Trees

Fresh and dry weight of leaves, content of MDA, proline, and protein increased in both healthy and infected plants under electromagnetic fields, compared with those of the control plants. EMFs decreased hydrogen peroxide and carbohydrates content in both healthy and infected 2-year old Lime trees compared to those of the controls (Abdollahi 2012).

Water

Electromagnetic-treated water was found to have diverse biological effects on both animal and plant cells (Yamabhai 2014).

References

Abdollahi F et al 2012 - *Biological Effects of Weak Electromagnetic Field on Healthy and Infected Lime (Citrus aurantifolia) Trees with Phytoplasma* ScientificWorldJournal 2012:716929 PMID: 22649313

Bilalis DJ et al 2012 - *Investigation of pulsed electromagnetic field as a novel organic pre-sowing method on germination and initial growth stages of cotton* Electromagn Biol Med 31(2):143-50 PMID: 22268861

Costanzo E 2011 - *Influence of extremely low-frequency electric fields on the growth of Vigna radiata seedlings* Bioelectromagnetics 32(7):589-92 PMID: 21416477

Efthimiadou A et al 2014 – *Effects of presowing pulsed electromagnetic treatment of tomato seed on growth, yield, and lycopene content* ScientificWorldJournal 2014:369745 PMID:25097875

Gagliano M et al 2012 - *Acoustic and magnetic communication in plants: Is it possible?* Plant Signal Behav 7(10):1346-8 PMID: 22902698

Javed N et al 2011 - *Alleviation of adverse effects of drought stress on growth and some potential physiological attributes in maize (Zea mays L.) by seed electromagnetic treatment* Photochem Photobiol 87(6):1354-62 PMID: 21883242

Jinapang P et al 2010 - *Growth characteristics of mung beans and water convolvuluses exposed to 425-MHz electromagnetic fields* Bioelectromagnetics 31(7):519-27 PMID: 20564175

Perez V H et al 2007 - *Bioreactor coupled with electromagnetic field generator: effects of extremely low frequency electromagnetic fields on ethanol production by Saccharomyces cerevisiae* Biotechnol Prog 23(5):1091-4 PMID: 17663568

Poinapen D et al 2013 - *Seed orientation and magnetic field strength have more influence on tomato seed performance than relative humidity and duration of exposure to non-uniform static magnetic fields* J Plant Physiol 170(14):1251-8 PMID: 23759543

Potenza L et al 2012 - *Effect of 300 mT static and 50 Hz 0.1 mT extremely low frequency magnetic fields on magnetic Tuber borchii mycelium* Can J Microbiol 58(10):1174-82 PMID: 23061534

Qiu Z et al 2011 - *Microwave pretreatment can enhance tolerance of wheat seedlings to CdCl2 stress* Ecotoxicol Environ Saf 74(4):820-5 PMID: 21145593

Radhakrishnan & B D Kumari 2013 – *Influence of pulsed magnetic field on soybean (Glycine max L.) seed germination, seedling growth and soil microbial population* Indian J Biochem Biophys 50(4):312-7 PMID: 24772951

Radhakrishnan R & B D Ranjitha Kumari 2012 - *Pulsed magnetic field: a contemporary approach offers to enhance plant growth and yield of soybean* Plant Physiol Biochem 51:139-44 PMID: 22153250

Roux D et al 2008 – *High frequency (900 MHz) low amplitude (5 V m(-1)) electromagnetic field: a genuine environmental stimulus that affects transcription, translation, calcium and energy charge in tomato* Planta 227(4):883-91 PMID: 18026987

Sharma VP et al 2009 – *Mobile phone radiation inhibits Vigna radiata (mung bean) root growth by inducing oxidative stress* Sci Total Environ 407(21):5543-7 PMID: 19682728

Singh HP et al 2011 – *cell phone electromagnetic field radiations affect rhizogenesis through impairment of bichemical processes* Environ Monit Assess 184(4):1813-21 PMID: 21562792

Tkalec M et al – 2009, *Effects of radiofrequency electromagnetic fields on seed germination and root meristematic cells of Allium cepa L*, Mutat Res 672(2):76-81 PMID: 19028599

Vashisth A & S Nagarajan 2010 - *Effect on germination and early growth characteristics in sunflower (Helianthus annuus) seeds exposed to static magnetic field* J Plant Physiol 167(2):149-56 PMID: 19783321

Yamabhai M et al 2014 – *Diverse Biological effects of electromagnetic-treated water* Homeopathy 103(3):186-92 PMID: 24931750