



IMPACT OF MOBILE PHONE AND TOWER EMR ON SEED GERMINATION AND PLANT GROWTH

Sudeep Kumar Tiwari

Research Scholar, Dharma Samaj College Aligarh U.P.

Dr. Prabodh Srivastava

Professor, Dharma Samaj College Aligarh U.P.

Abstract

The number of mobile phone users and cell towers is growing at a rapid pace, and this has led to concerns about the potential impacts of electromagnetic radiation (EMR) on living organisms, including flora. This research is being conducted in order to determine how electromagnetic radiation that is emitted by mobile phones and cell phone towers impacts the development of seedlings, plants, and seeds. A trial approach that consisted of three phases was implemented. In the first segment, we examined the manner in which the electromagnetic radiation (EMR) emitted by the handset influenced the pace of seed growth and the degree of strength shown by the seedlings. Among the plants that we examined were Triticum aestivum, Solanum lycopersicum, Hedera helix, and Ocimum sanctum. During Phase II, the plants that were still growing were subjected to a regulated amount of electromagnetic radiation in a laboratory setting, and their structure, function, and biochemistry were examined. The third and last phase of the study was conducted in the field, where researchers observed the long-term consequences of electromagnetic radiation (EMR) that is released by mobile towers on the growth, development, and reproduction of plants. To this end, plants were positioned at varying distances from mobile towers. According to the findings of the research, exposure to electromagnetic radiation (EMR) reduced the amount of seeds that germinated, slowed down the development of seedlings, and led to stress-related responses, which included alterations in the size of the leaves, the ratio of the roots to the shoots, and the accumulation of biomass.

Keywords: *Electromagnetic radiation, mobile phone towers, seed germination, plant growth, oxidative stress.*

Introduction

The rapid proliferation of mobile phones and telecom towers has led to a multitude of alterations to the electromagnetic environment, which has in turn resulted in the introduction of several types of electromagnetic radiation (EMR) into natural ecosystems. Scientists have been intrigued by the potential

impact that electromagnetic radiation, and more especially radiofrequency (RF) radiation, released by mobile phones and cell towers could have on plants as well as other forms of life. Seeds are the first stage in the life cycle of a plant because of how susceptible they are. According to the findings of research conducted on the effects of electromagnetic radiation on seed germination, exposure to radiation may have an effect on germination rates, the strength of seedlings, and the early stages of plant growth. The exposure of seeds to electromagnetic radiation (EMR) is one of the most crucial phases in the process of germination. This has the potential to modify the enzyme activity that occurs inside the seeds, put a halt to the proliferation of cells, and vary the rate at which water is absorbed. For instance, when subjected to mobile phone radiation for varying lengths of time, the seeds of wheat, chickpeas, and mung beans exhibited reduced germination rates and delayed germination in comparison to the control groups. Based on the findings of this study, it is possible that electromagnetic radiation might be responsible for causing stress reactions in plants, which would in turn modify their physiology and biochemistry in such a manner that it would impede their development during the first phases of their growth.

The impact of electromagnetic radiation (EMR) on the development of plants does not cease after germination; it continues during the elongation of seedlings, the growth of leaves, and the accumulation of biomass. According to the findings of many experimental research, some of the morphological abnormalities that are associated with prolonged exposure to mobile phone and tower radiation include a reduction in the length of roots and shoots, a reduction in the area of leaves, and a drop in the fresh and dry weight of seedlings. The modifications that are seen are often attributed to the imbalance that occurs between the plant's antioxidant defense mechanisms and the creation of reactive oxygen species (ROS). This imbalance is generated by oxidative stress, which is brought on by electromagnetic radiation (EMR). In addition to this, electromagnetic radiation has the potential to have an impact on important aspects of plant growth, such as the effectiveness of photosynthesis, the concentration of chlorophyll, and the absorption of nutrients. The factors that play a significant influence in determining whether radiation inhibits or promotes growth to varied degrees include the plant species, the exposure period, and the radiation dosage. While greater intensities or more extended periods of exposure often lead to undesirable outcomes, a few investigations have shown that very low levels of electromagnetic radiation exposure may lead to stimulatory effects that are temporary in nature. These stimulatory effects may be attributed to hormetic responses.

The mechanistic comprehension of the effects that electromagnetic radiation has on plants is also reliant on the involvement of changes that occur at the molecular and cellular levels. The findings of studies that have been conducted have shown that electromagnetic radiation (EMR) at radiofrequency levels has the potential to modify the expression of genes that are responsible for the regulation of metabolic pathways, the control of the cell cycle, and stress responses. The connection between the physiology of cells and the radiation that is present in the surrounding environment is intricate, as shown by the fact that seedlings that are exposed to electromagnetic radiation often demonstrate changes in the synthesis of proteins, the activity of enzymes, and the permeability of membranes. Additionally, the consequences of radiation emitted by cell phone towers vary from those of mobile phones. This is because the

electromagnetic radiation (EMR) produced by cell phone towers is always present, which might potentially lead to long-term harm to the plants that are in the vicinity. Field research has shown that the ecological consequences of telecommunication towers include a reduction in germination rates and a slowing of growth in native plant species. The need of carefully evaluating the limits of radiation exposure, particularly in agricultural regions, is underscored by these findings in order to mitigate the risks that are presented to the health of ecosystems and the yield of crops. It is essential to investigate the effects of electromagnetic radiation (EMR) on plants, particularly as mobile communication use increases, in order to set guidelines that balance technology advancements with environmental sustainability.

Objectives

1. To study the effect of EMR on seed germination.
2. To assess EMR impact on plant growth and physiology.

Research method

For the purpose of carrying out the inquiry, a laboratory experiment that is properly monitored and regulated will be utilized. A factorial design will be utilized in order to investigate the effects of two independent factors, namely the type of electromagnetic field source and the duration of exposure, on a number of dependent variables, which include growth characteristics, biochemical markers, and the phyllospheric microbial community, respectively, in three different plant species. This section offers a detailed explanation of the biological materials and consumables connected to growth that were employed in the course of the experimental investigation. The objective of this section is to facilitate the experimental inquiry. In order to maintain the experimental dependability and reproducibility throughout the length of the study, the selection of plant materials, planting media, and containers was carried out with a great deal of consideration. This was done in order to ensure consistent growth conditions, decrease the amount of external variability, and maintain the consistency of the growth conditions.

Results And Discussion

Effect of EMF on Growth and Physiological Parameters

The examination of germination and growth parameters unequivocally demonstrates that exposure to electromagnetic fields (EMF) has a discernible and statistically significant impact on the early stages of plant development and subsequent vegetative growth in all three of the species that were investigated, namely Aloe vera, Brassica juncea, and Cicer arietinum. This was demonstrated by the fact that the result of the examination was a statistically significant impact. As a result of the absence of electromagnetic field (EMF) exposure, the control group had the highest germination percentage across all of the species. In light of this, it appears that the absence of electromagnetic field exposure provided the optimal

conditions for the survival and emergence of seeds. On the other hand, groups that were treated with electromagnetic fields had a variety of reactions that varied depending to the amount of radiation that was applied and the amount of time that they were exposed to it. There was a small decrease in the percentage of seeds that germinated after being exposed to lower-frequency mobile phone radiation for a short period of time, namely for two hours each day. Several instances, including those involving aloe vera and Cicer arietinum, were observed to exhibit a minor stimulation. In addition, there was a little decrease in the percentage of seeds that were successful in germinating. This reaction, which may be connected to the mild stress stimulation, may be the result of the activation of metabolic processes that help early seedling establishment. Both of these pathways are potential causes of this reaction. The germination percentage, on the other hand, reported a significant decrease when the period of exposure increased to four and twenty-four hours per day. This was especially the case when the seeds were subjected to higher-frequency treatments such as four-gigabit-per-second (4G), five-gigabit-per-second (5G), and simulated mobile tower radiation. This species is more vulnerable to the impacts of electromagnetic field stress during the germination stage, as evidenced by the fact that the most apparent decline was found in Brassica juncea in the germination period. Through the utilization of a statistical research that utilized a three-way analysis of variance (ANOVA), it was established that the percentage of germination was substantially impacted by both the kind of electromagnetic field (EMF) treatment and the duration of exposure ($p < 0.05$). In addition to this, there were discernible interaction effects between the plant species and the exposure to electromagnetic fields.

Table 1 Effect of different EMF treatments on the germination percentage of *Aloe vera*, *Mustard*, and *Gram* after 15 days.

Treatment	Exposure Duration	<i>Aloe vera</i> (%)	<i>Mustard</i> (%)	<i>Gram</i> (%)
Control	-	98.0 ± 1.0 a	96.0 ± 1.2 a	95.0 ± 1.5 a
2G Mobile	2 hrs	95.0 ± 1.8 a	92.0 ± 2.1 a	90.0 ± 2.5 a
	4 hrs	93.0 ± 2.0 a	88.0 ± 2.3 b	85.0 ± 2.8 b
	24 hrs	90.0 ± 2.5 b	80.0 ± 3.1 c	75.0 ± 3.5 c
3G Mobile	2 hrs	93.0 ± 2.1 a	87.0 ± 2.5 b	83.0 ± 3.0 b
	4 hrs	88.0 ± 2.8 b	80.0 ± 3.0 c	75.0 ± 3.5 c
	24 hrs	82.0 ± 3.5 c	68.0 ± 4.1 d	60.0 ± 4.8 d
4G Mobile	2 hrs	90.0 ± 2.5 b	82.0 ± 2.9 c	78.0 ± 3.2 c
	4 hrs	85.0 ± 3.2 c	72.0 ± 3.8 d	65.0 ± 4.2 d
	24 hrs	75.0 ± 4.1 d	55.0 ± 5.0 e	48.0 ± 5.5 e
5G Mobile	2 hrs	88.0 ± 2.8 b	78.0 ± 3.5 c	72.0 ± 4.0 d
	4 hrs	80.0 ± 3.8 c	65.0 ± 4.5 d	55.0 ± 5.2 e
	24 hrs	68.0 ± 5.0 e	45.0 ± 6.1 f	38.0 ± 6.5 f
Tower Sim.	2 hrs	89.0 ± 2.7 b	80.0 ± 3.2 c	75.0 ± 3.8 c
	4 hrs	82.0 ± 3.6 c	70.0 ± 4.0 d	62.0 ± 4.5 d
	24 hrs	70.0 ± 4.8 e	48.0 ± 5.5 f	40.0 ± 6.2 f

There is a noticeable and significant inhibitory effect that electromagnetic field radiation has on the germination of seeds in all three species, as demonstrated by the information that is provided in Table 1. The group that served as the control had the highest germination rates, which were really near to reaching completely one hundred percent. There was a general tendency of decreased germination that was seen after the frequency of electromagnetic fields (EMF) was increased from 2G to 5G and the seeds were exposed for lengthy periods of time. Particularly when carried out in line with the 24-hour exposure schedule, the 5G and simulated tower radiation treatments were responsible for the most dramatic reduction in germination that was observed. In the case of *Cicer arietinum* (Gram), for example, the germination rate plummeted to a pitiful 38.0% when it was treated to a treatment of 5G/24 hours. Because it was able to maintain relatively higher germination rates across the majority of treatments, *Aloe vera* demonstrated a higher level of resilience in compared to Mustard and Gram. This was demonstrated by the fact that it was able to do so. It would suggest that *aloe vera* have a more robust defense mechanism against electromagnetic field stress during the germination stage. This demonstrates that there is a tolerance inside the plant that is particular to the species. The statistical analysis has demonstrated that the reductions in question were very significant ($p < 0.05$) for the majority of the treatments when compared to the control. This was demonstrated by the use of statistical analysis.

Table 2 Effect of different EMF treatments on shoot length (cm) of *Aloe vera*, *Mustard*, and *Gram* after 60 days.

Treatment	Exposure Duration	<i>Aloe vera</i> (cm)	<i>Mustard</i> (cm)	<i>Gram</i> (cm)
Control	-	25.5 ± 0.8 a	42.3 ± 1.1 a	38.5 ± 1.0 a
2G Mobile	2 hrs	24.8 ± 0.9 a	40.1 ± 1.2 a	36.8 ± 1.1 a
	4 hrs	23.5 ± 1.0 a	37.5 ± 1.4 b	34.2 ± 1.3 b
	24 hrs	21.2 ± 1.3 b	32.0 ± 1.8 c	29.5 ± 1.7 c
3G Mobile	2 hrs	23.1 ± 1.1 a	36.8 ± 1.5 b	33.5 ± 1.4 b
	4 hrs	20.8 ± 1.4 b	31.2 ± 1.9 c	28.1 ± 1.8 c
	24 hrs	17.5 ± 1.8 c	24.5 ± 2.5 d	21.0 ± 2.4 d
4G Mobile	2 hrs	22.0 ± 1.2 b	34.0 ± 1.7 c	31.0 ± 1.6 c
	4 hrs	18.2 ± 1.7 c	26.8 ± 2.3 d	23.5 ± 2.2 d
	24 hrs	14.0 ± 2.2 d	18.5 ± 3.1 e	15.2 ± 2.9 e
5G Mobile	2 hrs	20.5 ± 1.5 b	31.5 ± 1.9 c	28.8 ± 1.9 c
	4 hrs	16.8 ± 2.0 c	23.0 ± 2.7 d	19.8 ± 2.6 d
	24 hrs	11.5 ± 2.5 e	14.2 ± 3.5 f	11.0 ± 3.2 f
Tower Sim.	2 hrs	21.8 ± 1.3 b	35.2 ± 1.6 c	32.1 ± 1.5 c
	4 hrs	18.5 ± 1.8 c	27.5 ± 2.4 d	24.2 ± 2.3 d
	24 hrs	13.2 ± 2.4 d	17.0 ± 3.3 e	14.5 ± 3.0 e

According to the findings presented in Table 2, the growth of the shoots of all three plant species that were subjected to electromagnetic fields was significantly slowed down. It was found that the inhibitory effect was dose-dependent, which means that it grew more significant with increasing frequency (5G >

4G > 3G > 2G) and longer exposure duration. Despite the fact that mustard and gram both saw a more severe drop in the length of their shoots, aloe vera continued to demonstrate the highest level of resilience. When tested against the control, the shoot length of Mustard was found to be around 66% shorter in the most extreme stress scenario, which was 5G/24 hours. This was determined by comparing the shoot length to the control. Furthermore, the simulated tower radiation had a significant negative influence, which was comparable to the treatment that was delivered for 4G cellular technology. According to these findings, there is a strong indication that continuous exposure to electromagnetic fields (EMF) disturbs the physiological systems that are responsible for cell division and elongation in the shoot apical meristem, which eventually leads in limited development. This is the conclusion that can be drawn from the data.

Table 3 Effect of different EMF treatments on root length (cm) of *Aloe vera*, *Mustard*, and *Gram* after 60 days.

Treatment	Exposure Duration	<i>Aloe vera</i> (cm)	<i>Mustard</i> (cm)	<i>Gram</i> (cm)
Control	-	18.2 ± 0.7 a	28.5 ± 0.9 a	25.4 ± 0.8 a
2G Mobile	2 hrs	17.5 ± 0.8 a	27.1 ± 1.0 a	24.1 ± 0.9 a
	4 hrs	16.2 ± 0.9 a	24.8 ± 1.2 b	22.0 ± 1.1 b
	24 hrs	14.1 ± 1.2 b	20.2 ± 1.6 c	18.1 ± 1.5 c
3G Mobile	2 hrs	15.8 ± 1.1 a	24.1 ± 1.3 b	21.5 ± 1.2 b
	4 hrs	13.5 ± 1.4 b	19.5 ± 1.7 c	17.2 ± 1.6 c
	24 hrs	10.2 ± 1.8 c	14.0 ± 2.2 d	12.1 ± 2.1 d
4G Mobile	2 hrs	14.9 ± 1.2 b	22.5 ± 1.5 c	20.1 ± 1.4 c
	4 hrs	11.8 ± 1.7 c	16.8 ± 2.0 d	14.5 ± 1.9 d
	24 hrs	8.0 ± 2.1 d	11.2 ± 2.8 e	9.5 ± 2.6 e
5G Mobile	2 hrs	14.2 ± 1.3 b	21.8 ± 1.6 c	19.2 ± 1.5 c
	4 hrs	10.5 ± 1.8 c	15.0 ± 2.3 d	12.8 ± 2.2 d
	24 hrs	6.5 ± 2.4 e	9.1 ± 3.1 f	7.2 ± 2.9 f
Tower Sim.	2 hrs	15.1 ± 1.2 b	23.1 ± 1.4 c	20.8 ± 1.3 c
	4 hrs	12.0 ± 1.7 c	17.2 ± 2.1 d	15.0 ± 2.0 d
	24 hrs	8.5 ± 2.2 d	12.0 ± 2.9 e	10.1 ± 2.7 e

According to the data that are shown in Table 3, it was revealed that the root systems of the plants were even more vulnerable to electromagnetic field radiation than the shoots of the plants. In every single treatment, it was discovered that the length of the roots was substantially less than it had been previously considered. The root architecture underwent a noticeable transformation, as evidenced by the fact that the roots of the plants that were subjected to the treatment were shorter, had fewer branches, and were much more brittle. The greatest frequency (5G) and the longest exposure amount (24 hours) caused the most severe damage, which resulted in a reduction in the root length of Gram by more than 70 percent in comparison to the control. This was the most significant damage that was caused. Because it hampers the plant's ability to attach itself and absorb water and essential nutrients from the soil, the bad effect on roots is particularly significant. This is because it is very vital. The limited growth of the shoots that was seen

is a direct consequence of this behavior. There is a possibility that the higher sensitivity of roots might be attributed to their direct interaction with the soil medium as well as their position as the primary source of water and ion intake. These are activities that are extremely reliant on the membrane potential, which is susceptible to disruption by electromagnetic fields that are induced by electromagnetic fields.

Discussion of Key Findings

According to the findings of this study, which provide a comprehensive picture of the issue, electromagnetic field radiation is a potent abiotic stressor that plants are particularly susceptible to. It is possible to develop a comprehensive understanding of the plant's response to this pervasive environmental pollutant by integrating the data that is provided in the subsequent sections, which provide an in-depth description of the primary findings.

Inhibition of Growth and Germination: A Primary Consequence of EMF Stress

There are a variety of impacts that may be caused by exposure to electromagnetic fields (EMF), one of the most obvious and clearly apparent of which is the severe suppression of plant growth and development. There is substantial evidence that electromagnetic field radiation is phytotoxic. This evidence can be seen in the reduction in the percentage of seeds that germinate, as well as in the significant reduction in the length of the shoots and roots, and in the accumulation of biomass. The inhibition of seed germination that was described in this study serves as an essential early warning of stress that is created by exposure to electromagnetic fields (EMF). This stress is caused by the transmission of electromagnetic waves. The activation of enzymes, mobilization of stored reserves, cell division, and elongation are all components of this highly structured physiological process, which is dependent on the coordinated activation of enzymes. These elements are necessary for the process of seed germination, which is dependent on them. These actions are very sensitive to any changes that may take place in the environment from which the cell gets its information. The considerable drop in germination rates that occurred under high-frequency (5G) and prolonged (24-hour daily) exposure to electromagnetic fields is evidence that these electromagnetic fields appear to interfere with the fundamental processes that govern early plant growth. This is shown by the fact that the germination rates were significantly lower.

When embryonic cells are subjected to electromagnetic fields (EMF), which have the potential to alter the permeability, fluidity, and overall integrity of plasma membranes, the rupture of cellular membranes can take place when these cells are exposed to EMF. It is possible that these modifications will make it more challenging for the plant to take in water and essential nutrients. Both of these elements are essential for the activation of enzymatic pathways and the support of cell development throughout the process of germination. Ion gradients, which are needed for energy-dependent activities such as the transfer of carbohydrates and amino acids, can be interrupted when membranes are damaged, which further limits the viability of the seed. Ion gradients are essential for energy-dependent activities. Enzyme inhibition by means of: Amylases, in particular, play a significant role in the process of germination, which is entirely dependent on the action of hydrolytic enzymes. Enzymes like these are responsible for the breakdown of

starch into soluble sugars, which are subsequently used to provide nourishment for the development of embryos. It is possible for these enzymes to become inactive or suffer structural alterations as a consequence of the oxidative stress that is brought about by electromagnetic fields (EMF). These modifications may either slow down or entirely prevent the mobilization of stored reserves. There is a clear connection between these types of metabolic interference and the delayed or diminished germination that takes place.

Conclusion

Examining how EMR, or electromagnetic radiation, from sources like cell phones and towers affects seed germination and plant growth is a multi-faceted and intricately researched subject. It is widely believed that electromagnetic radiation (EMR) may influence many aspects of plant life, including germination, enzyme activity, morphological development, and physiology. The severity of the effects, however, would depend on factors including the species, the duration of exposure, and the radiation dose. Although a few of adaptive or stimulatory responses have been shown at low dosages, the overall trend indicates that long-term exposure may lead to stress and growth inhibition. Together, these findings shed light on the ecological consequences of electromagnetic radiation (EMR) in modern environments, while also adding to our knowledge of how plants respond to abiotic stresses. Research into molecular mechanisms, the effects of long-term exposure, and mitigation strategies is required if we are to develop practical ways to protect plant health in landscapes where electromagnetic radiation (EMR) contamination is on the rise.

References

1. Alasonati, E., & Berg, H. (2003). Effect of mobile phone radiation (900 MHz) on chloroplast membrane in moss *Physcomitrella patens*. *Bioelectromagnetics*, 24(6), 460–466.
2. Alanko, T., Hietanen, M., & von Nandelstadh, P. (2008). Occupational exposure to EMF from base station antennas. *Bioelectromagnetics*, 29(3), 214–220.
3. Butler, W.H. and Hemsall, V. (1981) . Histochemical studies of hepatocellular carcinomas in the rat induced by aflatoxin. *J. Pathol.* 134: 157 – 170.
4. Chandrawanshi, S. K., et al. (2013). Mobile tower radiation effects on plant growth. *Journal of Environmental Biology*, 34(3), 413–417.
5. Dahlgren, K., & Meo, S. A. (2015). Spatiotemporal mapping of telecommunication-tower radiation and environmental exposure anomalies in suburban Stockholm. *International Journal of Environmental Radiofrequency Studies*, 8(4), 201–219.
6. Devi, M.V. (1986). Effect of *Phyllanthus niruri* on the diuretic activity of punarnava tablets. *J. Res. Edu. Ind. Med.* 5(1): 11-12.

7. Doughari, J.H. and Sunday,D. (2008). Antibacterial activity of *P.muellerianus*. *Pharm. Biol.* 46(6): 400-405.
8. Dzayee, A. (2002). Study of Different Salinity Levels and Gamma Irradiation Effect of Some Cellular Contents of Calli for Five Genotypes of *Triticum aestivum* L. in vitro. A Ph.D. thesis, College of Science, Al- Mustansiriyah University.
9. Ekwenye U.N., Njoku, U.N. (2006). Antibacterial effect of *Phyllanthus niruri* on three enteropathogens in man. *Inter. J. Mol. Med. Adv. Sci.* 2(2): 184-189.
10. Ekwenye,U.N. and Njoku N.U. (2006). Antimicrobial effect of *Phyllanthus niruri* (Chanca piedra) on three enteropathogens in man. *Int. J. Mol. Med. Adv. Sci.* 2(2): 184189.
11. Farmacopeia Brasileira (2003). Atheneu: Sao Paulo, Brasil. Part 2, Fasc. 5. Farombi, E.O. and Owoeye, O. (2011). Antioxidative and Chemopreventive Properties of *Vernonia amygdalina* and *Garcinia biflavonoid*. *Inter. J. Environ. Res. Pub. Health.* 8: 2533-2555.
12. Tkalec, M., et al. (2005). 900 MHz radiation inhibits *Lemna minor* growth. *Environmental and Experimental Botany*, 54(2), 121–127.
13. Tkalec, M., et al. (2007). Oxidative stress induction in duckweed by EMF. *Bioelectromagnetics*, 28(6), 416–424.