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The Effect of Cell Phone Signal in the Near-Field Region

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Abstract

Numerous studies have been conducted to understand the effect of radio frequency (RF) signals normally emitted by cell phones on living organisms. Few studies however addressed the effects on plants which are easier to study and whose cells have a basic structure very similar to those of animals and humans – thus we can use the results on plants to understand the effects on humans. We conducted a study to determine if direct RF radiation from a cell phone influences the growth of a tomato plant. Unlike other studies, our work focused on the correlation of plant growth with the distance from the cell phone antenna. We found that the plants exposed to the RF radiation grew taller and more massive than the unexposed plants. In addition, we observed two trends of growth indicating a cut-off of the Near-Field region. In the Near-Field region, the plants were affected more by the RF radiation as the distance increased from the cell phone antenna in opposite trend to what is expected from the Far-Field region in which the electromagnetic wave is fully established, and its effect dies down as the distance increased from the wave source.

Keywords: Cell Phone effects, RF radiation

1 Introduction

The usage and advancement of smart phones, Wi-Fi internet and other forms of electronic communication is sharply rising. While this technology has incredible benefits to the growing world, the increasing radiation exposure from these devices has alarmed many. Nevertheless, physicists, medical physicians and biologists alike are questioning whether such technologies are safe.

Cell phones and WiFi communicating devices operate at microwave frequencies. Though this can vary by service provider and location, a typical cell phone

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operates at frequencies of 800-1900 MHz and falls within the range of frequencies called radio frequencies (RF) from 0.3 to 300 GHz [1]. Numerous experiments have been conducted to determine whether RF radiation is harmful, neutral or even beneficial to various living organism. Many of the experiments yielded conflicting results. For example, Hirose et. al. [2] tested RF radiation on in vitro human cells and concluded that this radiation did not induce cell transformation in the exposed cells. Whereas Esmekaya [3] studied the effect of pulsed modulated RF radiation on rats and found it to cause lipid peroxidation, nitrogenic stress, and antioxidant suppression in various tissues. And Michael et al. [4] found significant thermal effect on old rats exposed to cell phone radiations. Some other experiments are in these references: [5,6,7,8,9,10].

Most of the published studies, however, have been performed on human and animal cell cultures, while far fewer studies conducted on plants. Plants, nevertheless, can serve as models to test the effect of RF on living organisms because they respond to environmental stimuli with high specificity [11]. One study exposed Oil Bearing seeds to RF radiation and noted increased rates of germination [12]. Another study [13] looking into the effects of RF radiation on Aspen plants found exposed plants displayed a reduction in shoot length and leaf area among other things. Vian et. al. [14] grew tomato plants in a microwave frequency induced environment and discovered that a frequency of 850 MHz radiation caused enhanced transcription of one of the stress genes.

Although there are varying conclusions from the limited number of studies conducted on the effect of RF signals on plants, none of these studies, to our knowledge, considered the effect as a function of distance from the source of the RF radiation. In this study, we used a commercial cell phone as the source of the RF radiation and we monitored the effect of these radiations on plants at various distances from the phone. Using a commercial cell phone instead of RF generating machine should bring out the realistic effect of cell phones on living organism.

2 Preliminary Notes

We used Motorola V190 cell phone with an exposed antenna, operating at 850 MHz frequency by AT&T phone services, on Washington cherry tomato plants known as solanum lycopersicum. An offsite computer was used to call the cell phone to produce the RF radiation from the phone. There were ten plants in the exposed group arranged linearly in 5 cm increments, with the closest being 5 cm and the farthest being 50 cm from the antenna of the phone. The duration of the experiment lasted 35-days beginning with plantation, during which, the computer called the phone for 120 minutes each day. Prior to plantation, we germinated the seeds by using a filter paper which was placed in a petri dish and dampened with about 30 mL of ionized water and a Parafilm was wrapped tightly around the petri

dish. All plants were grown in a BioChamber GC-16 growth chamber that allowed us to set temperature, humidity, CO_2 levels and lighting; and Potting Soil Mix #1 was used for plantation. Another ten control plants were grown under the same conditions but were unexposed to the cell phone signal to serve as bases for comparison.

3 Main Results

After 35 days of growth, we recorded the height of each of the ten control plants and each of the ten RF-exposed plants. We found that, except for one plant that was closest to the cell phone, the plants that were exposed to the cell phone signal were taller than the control plants, with one plant being 5 cm taller, see Figure 1. Next, each plant was removed from the soil, gently brushed off, and thoroughly rinsed. Each plant was placed in a paper bag and into an oven at 62 ºC for 24 hours. The plants were then removed from the oven and their mass was measured on a scale to obtain a total dry mass including roots, stems and leaves. We found that the average dry mass of the ten-cell phone-exposed plants to be 0.7735 grams while the average dry mass of the ten control plants was 0.4787 grams – the exposed plants were on average about 62% heavier than the control plants.

We see two trends in Figure 1, one is proximal and the other distal to the ~ 35 cm mark from the antenna of the cell phone. This distance almost exactly equals the wavelength (λ = 35.3 cm) of the cell phone signal that we used -- corresponding to the frequency of 850 MHz used by AT&T for our phone. Since the most agreed upon definition of the Near-Field region is the region below one wavelength (or λ = 35.3 cm in our case) from the antenna [1], we are encouraged to believe that we may have sensed the Near-Field effect in the region to the left of the 35.3 cm vertical dotted line in Figure 1.

In the Near-Field region, E and B are decoupled and not necessarily perpendicular to each other. Only in the Far-Field region are both E and B related, and their fields have the characteristics of a propagating wave [1]. In Figure 1, we see that below the 35.3 cm cut-off, the plant length was affected more (became taller) by the RF radiation as the distance increased from the cell phone antenna. This is not the behavior of a fully developed electromagnetic wave whose effect is expected to diminish with increasing distance from the wave source. After the 35.3 cm cut-off however, the plant length appeared to decrease, though slightly, with increasing distance from the cell phone.

4 Labels of figures and tables

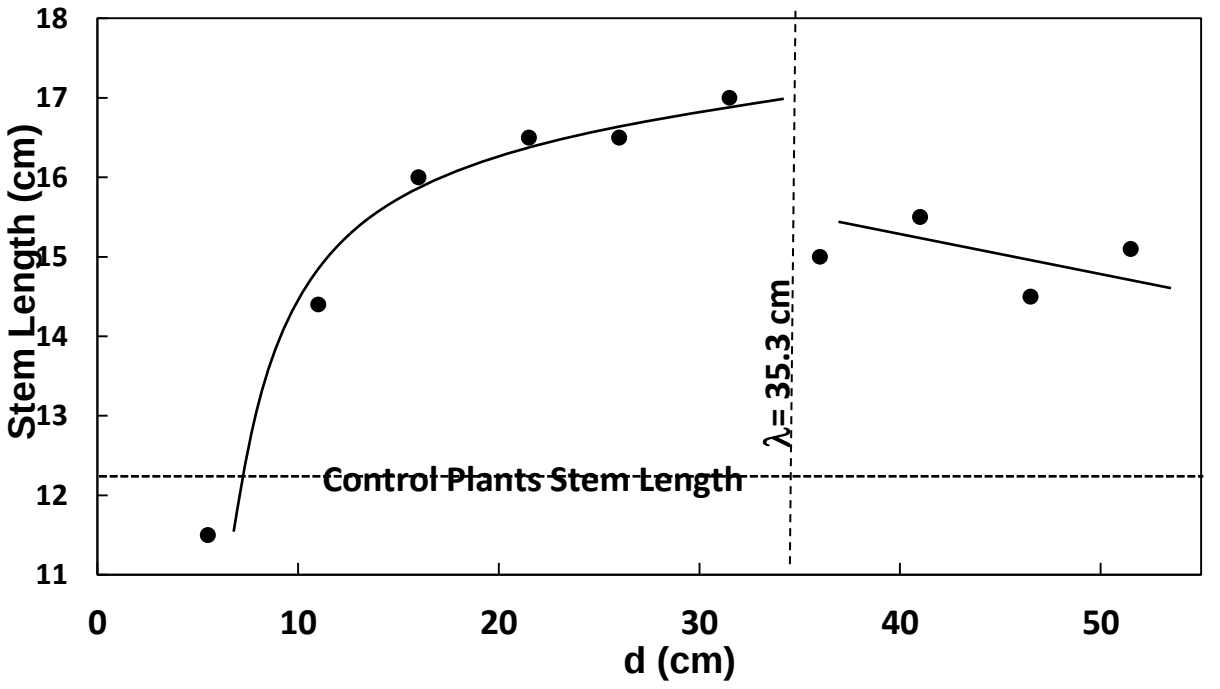

Figure 1: Stem length (solid points) of the RF-exposed plants versus distance from the cell phone antenna – the solid lines are only to guide the eyes. The dotted horizontal line represents the average length of the control plants.

5 Conclusion

In this preliminary study, we found that our tomato plants in general grew taller and gained mass when exposed to RF signals emitted by a commercial cell phone. The different effects of the cell phone signal on our plants proximal and distal to $\lambda = 35.3$ cm, strongly suggest to us that we may have identified the Near-Field region of the cell phone we used. To that end, our data may give us a better indication of how cell phone signals affect our brain. For example, when we place a cell phone on one of our ears, the signal of the phone will presumably navigate through the brain within the near-field region. That is because the distance between the two ears is about 15 cm --a cell phone placed on one ear will cause a signal to travel in the brain a total distance of about 15 cm from ear to ear, which is within the Near-Field region according to our findings in Figure 1. Our findings suggest that the cell phone signal will have a stronger effect as it travels farther into the brain from the ear where the cell phone is placed, just like our plants grew

taller as the distances increased from the cell phone in the Near-Field region. This is contrary to the common belief that the cell phone signal effect dies down as the distance increases from the location of the phone.

Although our study gathered evidence about phenotypic features of the plant from RF radiation, the next step would be to test how RF influences plants at the molecular level. This would mean testing to see if RF radiation has an effect on DNA and gene imprinting and whether or not that manifests in the visible features of the plant. Such studies would give us more evidence about the degree to which RF radiation can influence living creatures and our health.

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