BION, INŠTITUT ZA BIOELEKTROMAGNETIKO IN NOVO BIOLOGIJO, d.o.o.
BION, INSTITUTE FOR BIOELECTROMAGNETICS AND NEW BIOLOGY, Ltd.

Stegne 21, SI-1000 Ljubljana, Slovenia, EU
t: +386 (0)1 513 11 46 **m:** +386 (0)51 377 388
e: info@bion.si **i**: http://bion.si

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SCIENTIFIC REPORT ON TESTING PROTECTIVE INFLUENCE ON GERMINATING BEAN SEEDS (*Phaseolus Vulgaris*) AGAINST WIRELESS ROUTER RADIATION

FOR THE PRODUCT

Qi-Shield

Customer

Qi-Technologies GmbH
Niederkainaer Straße 11
02625 Bautzen
Germany

t: +3591-5947543

Research institution

BION, Institute for Bioelectromagnetics and New Biology, Ltd.
Research organization code No.: 0431
Stegne 21
SI-1000 Ljubljana
Slovenia. EU

m: +386 (0)51 377 388
t: +386 (0)1 513 11 46
e: info@bion.si
i: www.bion.si/en

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INŠTITUT BION bion d.o.o. Ljubljana

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1 INTRODUCTION

One of the scientific fields of research at the BION Institute is measuring the effects of weak radiation that cannot be measured by conventional measuring devices. Even the unconventional technical devices are not yet capable of measuring this kind of radiation (in physical or chemical effects) reliably enough. Nevertheless, technology is constantly evolving also in this direction. Mostly, this kind of radiation and its effects cannot be explained by a commonly accepted theoretical (physical) interpretations, although some scientists have offered possible explanations.

BION Institute has specialized in scientific measuring of biological effects of weak emission of various devices. In many years of research, the researchers at the BION Institute developed a series of tests with specific sensor systems that enable us to give a valid assessment of the supposed biological influence or non-influence of weak emission devices. This could mean a stimulating influence or a protective one against negative radiation from the environment. If the effects of the supposed emission are statistically significant, we issue the appropriate certificate.

In the present testing, we used the sensor system composed of germinating beans under a controlled (heat, temperature) stress (from now on called also C-stress). Namely, from our long experience in bioelectromagnetics research, we know that relatively subtle effects of various types of electromagnetic field irradiation (here Wi-Fi exposure) can clearly reveal itself only after some other stress. In the present testing, we followed two scenarios: a cruder (a) and a more subtle (b) one. In (a) the seeds were exposed to harmful Wi-Fi radiation *after* the C-stress, while in (b) they were exposed to the irradiation *before* the C-stress. In (a), we expected that the Wi-Fi stress would further inhibit the germinating of seeds, while the assumed Qi-Shield would reverse this inhibition so that the germination would move towards Wi-Fi non-exposed seeds (but still exposed C-stress). In (b), following our own (cit. lit.) previous and other similar experiments, we expected that the preliminary Wi-Fi exposure would present mild stress that would prepare germinating seeds for the bigger C-stress. In this case, therefore, the seeds under Wi-Fi exposure should germinate better than control. A normal expectation for a possible Qi-Shield protection here was that by shielding from Wi-Fi exposure the Qi-Shield protected seeds would germinate worse, perhaps even worse than control.

2 MATERIALS AND METHODS

The company Qi-Technologies GmbH, ordered testing of a supposed protective influence of the Qi-Shield device (Figure 1) for evaluation of the protective effects on germinating beans against wireless router radiation (from now on Wi-Fi). We exposed beans to two types of controlled stress (the already mentioned C-stress): heat stress (42°C for 30 minutes) and water stress (no water for 22 hours). Additionally, we exposed germinating beans to Wi-Fi radiation and/or Qi-Shield and observed changes in the growth of beans. After the experiment, we weighted the seedlings and determined the effects of the tested device.

Figure 1: Qi-Shield device used in testing.

The tests were conducted from 1st to 30th August 2019 at the BION Institute. The testing was divided in two stages. In preliminary tests, we optimized combinations of growing and stress conditions (heat, drought, Wi-Fi radiation) to ensure reliable measurements and determine the optimal influence of heat and temperature stress on germinating beans. In the second stage, we exposed beans to various combinations of Wi-Fi radiation, Qi-Shield (True or Sham) and C-stress conditions.

We performed two experiments. Each experiment consisted of two series and of five phases: soaking seeds, germination of seeds, temperature stress, water stress, and growth (Table 1). In series 1 and 2, beans were exposed to Wi-Fi and/or Qi-Shield during the C-stress and the growth phase. In series 3 and 4, beans were exposed to Wi-Fi before the C-stress. In situations, where Qi-Shield was present, seeds were exposed to a device during the whole series. See Table 2 for more details.

At the end of each experiment, we weighted hypocotyl and roots of beans (from now on seedlings) using analytical balance with a precision of 1 mg. We compared the weights of seedlings between experiments and series using t-test and ANOVA. Additionally, we calculated Hedges's g for effect size evaluation.

Table 1: Phases of experiments

Phase	**Duration**
Soaking seeds	4.5 hours
Germination of seeds	48 hours
Temperature stress	30 minutes
Water stress	22 hours
Growth	24 hours

2.1 EXPERIMENTAL PROCEDURE

For the testing, we used češnjevec, Slovenian indigenous bean species. We soaked approximately 150 beans in distilled water for 4.5 hours, after which we spread them on the glass trays with cotton pads, added water and covered with lids. We randomly put trays in either a growth chamber 1 or 2 (temperature 25°C, no light, see Figure 4), depending on the experimental setting. After 48 hours of germination, we carefully selected beans with the same size of roots and placed them in eight glass containers, five beans in each, this time without the cotton pads. We transferred open glass containers in an incubator at 42°C for 30 minutes (heat stress). After that, we covered the containers and put them back into the growth chambers for 22 hours without water (waters stress). Next day, we arranged beans on new cotton pads (Figure 2, left), added 30 ml of distilled water, covered with another layer of cotton pads, and returned them back to the growth chambers for another 24 hours. After the end of the experiment, we weighted the individual seedlings without secondary roots (Figure 3). We decided to remove them because small roots became trapped in the cotton pads; therefore, it was not possible to remove the whole roots with undamaged secondary roots, weighing them would entail an unnecessary increase of variability. We calculated the mean weight of seedlings within each experimental situation and compared it with mean weights from other experiments.

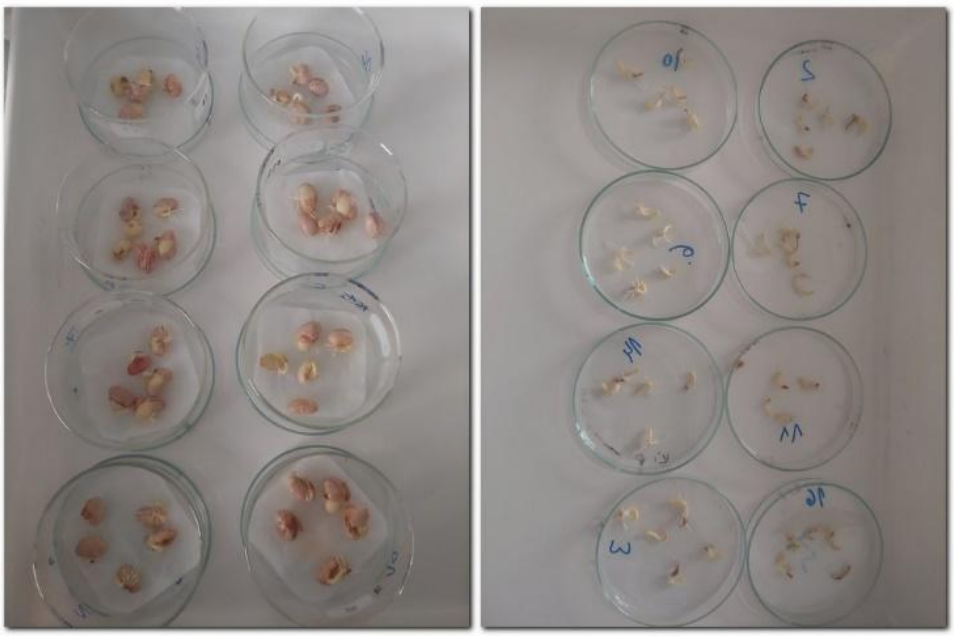

Figure 2: Germinating beans (left) and hypocotyls with roots separated from cotyledons (right)

Figure 3: Hypocotyls and roots of beans; marked are some of the secondary roots which were removed before weighting. We weighted individual seedlings and calculated mean values.

In each experimental setting, we prepared a set of four glass containers, five beans in each. We exposed them to various combinations of devices but not to the C-stress. These beans served as an internal control of each experiment.

Table 2: Detailed scheme of experiments and phases of exposure to various devices (Abbreviations: Exp. – experiment, Wi-Fi ON – Wi-Fi device was present and turned ON; Qi ON (True) – True Qi Shield was present; Qi OFF (Sham) – Sham Qi Shield was present in the chamber)

Exp.	Series	Situation	Growth chamber	Soaking and germination	Temp. stress	Water stress	Growth
A	A1	1	1	/	/	Wi-Fi ON, Qi ON (True)	Wi-Fi ON, Qi ON (True)
		2	2	/	/	/	/
	A2	3	1	/	/	/	/
		4	2	/	/	Wi-Fi ON, Qi OFF (Sham)	Wi-Fi ON, Qi OFF (Sham)
B	B1	5	1	Wi-Fi ON	/	/	/
		6	2	Qi ON (True)	(Qi ON)	Qi ON	Qi ON
	B2	7	1	Wi-Fi ON, Qi ON (True)	(Qi ON)	Qi ON	Qi ON
		8	2	/	/	/	/

In experiment A, we evaluated the protective influence of Qi-Shield against Wi-Fi radiation, using either true Qi-Shield or sham Qi-Shield. In control experiments, beans were exposed neither to Wi-Fi nor Qi-Shield.

In experiment B, beans were exposed to various combinations of Wi-Fi, (true) Qi-Shield or were not exposed to anything (control).

Figure 4: Growth chambers and arrangement of glass containers with beans. Left: control experiment, right: experiment where beans were exposed to Wi-Fi and Qi-Shield.

3 RESULTS WITH DISCUSSION

3.1 PRELIMINARY TESTS

In preliminary test, we were optimizing the effect of heat and water stress – C-stress – on germinating beans. Non-stressed beans were watered and not exposed to heat, while stressed beans were exposed to heat and drought. The weight of seedlings of C-stressed beans was 55% lower compared to non-stressed beans (Figure 5). The difference was statistically significant (non-parametric Kruskal-Wallis test, $p < 0.001$).

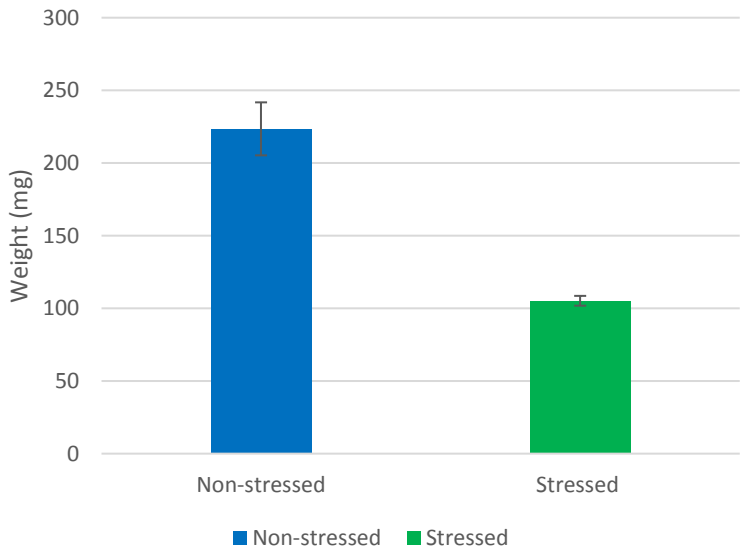

Figure 5: Comparison of weight of seedlings of unstressed and stressed (C-stress) beans. Presented are mean weights (in milligrams) and standard errors.

3.2 EXPERIMENT A

Comparison of active Wi-Fi and true or sham Qi-Shield showed the lowest growth of beans when they were exposed to Wi-Fi and sham Qi-Shield (Table 3, Figure 6). The weight of seedlings (mean value 91.2 mg) was significantly lower compared to control situation, but not compared to the situation where true Qi-Shield was present (ANOVA, $p < 0.05$). The weight of seedlings was the biggest in control situation (mean weight 105.2 mg), however, the difference was not significant compared to the situation with Wi-Fi and true Qi-Shield situation (mean weight 96.2 mg). The Hedge's g effect sizes are presented in Table 4.

Table 3: Mean weights of bean seedlings and standard errors of means in experiment A

	Weight (mg)	Standard error
Control	105.2	3.38
Wi-Fi ON, Qi-Shield ON (True)	96.21	4.66
Wi-Fi ON, Qi-Shield OFF (Sham)	91.26	4.14

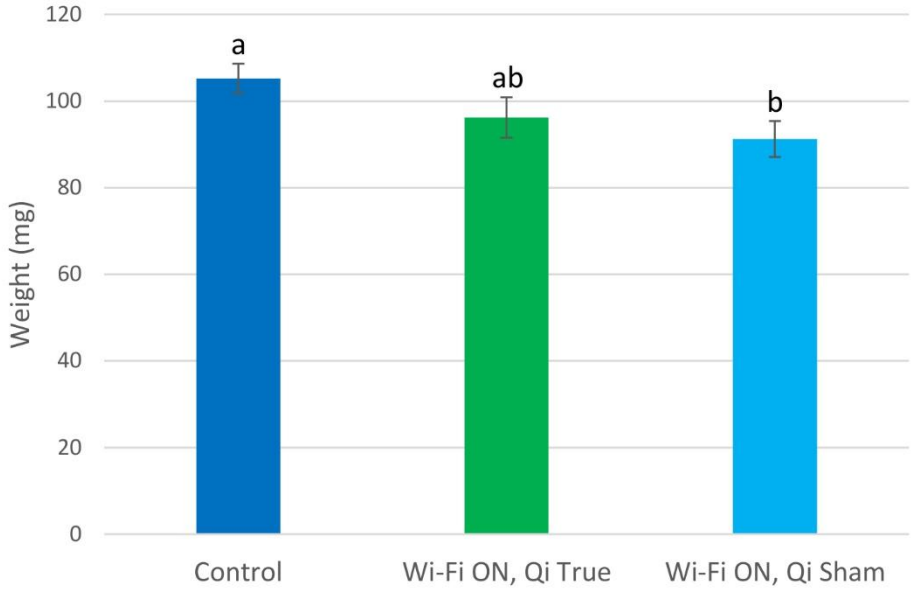

Figure 6: Comparison of weight of seedlings in control and combinations of Wi-Fi with either true or sham Qi-Shield. Mean weights (in milligrams) and standard variation are presented. The same letter above the histogram bars represent situations that are not statistically significantly different from one another; different letters denote statistically significant difference.

Table 4: Statistical significance and the effect size of weight of seedlings in experiment A.

	Wi-Fi ON, Qi-Shield ON (True)	Wi-Fi ON, Qi-Shield OFF (Sham)
Control	-0.336 p = 0.266	-0.516 p = 0.029
Wi-Fi ON, Qi-Shield ON (True)	/	-0.190 p = 0.709

We assume that the low growth rate of Wi-Fi ON + sham Qi-Shield group shows the expected inhibitory effect (g = -0.52) of Wi-Fi irradiation on germinating seeds. On the other hand and as expected, the true Qi-Shield ameliorated the inhibitory effect (g = -0.33), even if not in a statistically significant manner.

3.3 EXPERIMENT B

Based on the results from the experiment A, we decided to perform an additional experiment where we exposed beans to Wi-Fi in the soaking and germination phases rather than in growing phase. We wanted to find out if Wi-Fi radiation induces stress in plants and prepares them on stress that follows later in the growing phase.

Results showed the lowest growth with a mean weight of seedlings 94.6 mg in the situation when beans were exposed to Wi-Fi and Qi-Shield (Table 5, Figure 7). The weight of seedlings was 21 % lower compared to control. The highest mean weight of seedlings (122.1 mg) was

measured in the situation with Wi-Fi only, while in the situation when only Qi-Shield was present the beans' growth was lower than in the Wi-Fi only situation and higher compared to the combination where both Wi-Fi and Qi-Shield were present. For the effect size, see Table 6. Statistical analysis showed that there was a significant difference between the weight of seedlings when beans were exposed to Wi-Fi and Qi-Shield and weight of seedlings of Wi-Fi only and control situations (ANOVA, $p < 0.05$).

Table 5: Mean weights of bean seedlings and standard errors of means in experiment B

	Weight (mg)	Standard error
Control	115.6	5.3
Wi-Fi only	115.7	5.06
Qi-Shield only	106.6	4.73
Wi-Fi ON, Qi-Shield On	94.61	3.38

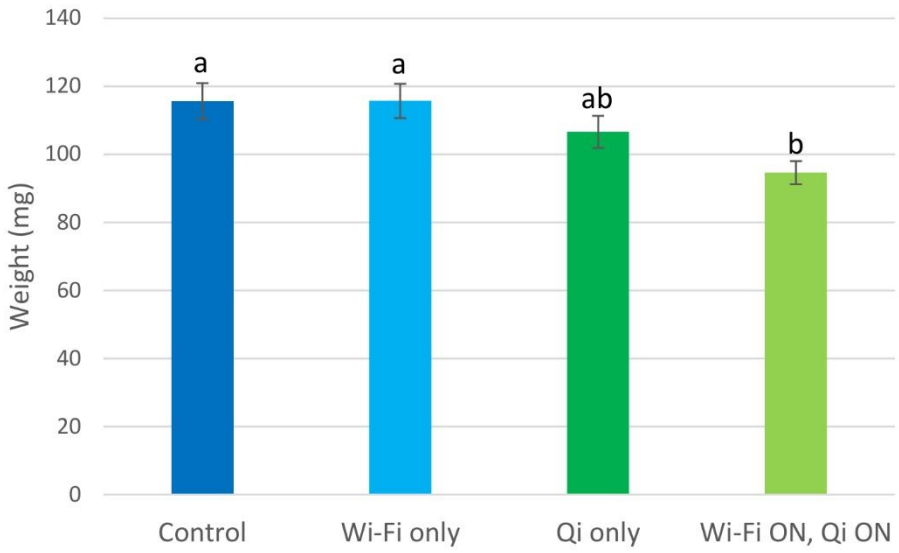

Figure 7: Comparison of weight of seedlings in control situation and various combinations of Wi-Fi and Qi-Shield presence during the experiment. Mean weights (in milligrams) and standard variation are presented. The same letter above the histogram bars represent situations that are not significantly different from one another; different letters denote statistically significant difference ($p < 0.05$).

Table 6: Statistical significance and the effect size of weight of seedlings in experiment A.

	Wi-Fi only	Qi-Shield only	Wi-Fi ON, Qi-Shield ON
Control	0.003 p = 1.0	-0.290 p = 0.509	-0.902 p = 0.007
Wi-Fi only		-0.308 p = 0.534	-0.812 p = 0.010
Qi-Shield only			-0.468 p = 0.244

As expected and explained in Introduction, in this experiment (exp. B) the effect of Wi-Fi did not have inhibitory effects but rather slightly increased the growth of seedlings. Here, Wi-Fi exposure worked in a stimulatory way and helped to prepare the seeds to other types of stress. On the other hand, and again in line with expectations, the lowest growth rate in the situation with Wi-Fi and Qi-Shield showed as if the latter protected seeds against Wi-Fi exposure and thus did not prepare them for combatting the C-stress. Therefore, regarding the relation between Wi-Fi plus Qi-Shield vs. Wi-Fi plus *sham* Qi Shield, the difference clearly speaks in favour of protecting effect of Qi-Shield.

The question remains, why the Wi-Fi plus Qi-Shield exposed seeds germinated worse than control where there was no specific exposure. Our interpretation of this difference is that Qi-Shield initiated physiological processes that result in the seeds that were more "cautious", more parsimonious or economical after the C-stress, perhaps to be better prepared for another possible stress. We would remind the reader that the seeds were under Qi-Shield irradiation all the time and not only before and during the C-stress – as it would be presumably done in a real protective situation. This effect is corroborated by the results of the Qi-Shield only exposure, where the seeds' germination was still somewhat, even if not statistically significant and with a moderate effect size ($g = -0.29$), inhibited. Since the stress in this situation is expected to *enhance* germinating, the inhibitory effect can be ascribed to more economical, cautious use of resources.

4 CONCLUSION

According to the results of both experiments, we may conclude that the Qi-Shield

1. indicate a shielding effect on Wi-Fi radiation (results of the 1st experiments and the comparison between sham Qi-Shield and true Qi-Shield results (both Wi-Fi ON situations) in the 2nd experiments).
2. the 2nd experiment shows that Qi-Shield (alone but even more obvious in conjunction with Wi-Fi exposure) can induce more complex physiological changes in germinating seeds that either the seedlings make more sensitive to stress or make them more cautious in using the resources.
3. For a prediction of long-term effects of simultaneous exposure to Wi-Fi and Qi-Shield, another, lengthier testing should be performed. The same holds for the Qi-Shield only situation.

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