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Nanometric intrinsic fluctuation observed in ultra-short term growth behavior of *Myriophyllum aquaticum* stem under radio frequency electromagnetic radiations using Statistical Interferometry

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Radio frequency electromagnetic radiation (EMR) in the environment is increasing with the extensive deployment of communication base-stations. There is a wide concern regarding the effects of EMR on humans and other animals and resent findings confirms effect of EMR on them [1, 2]. The literatures on EMR effect on plants are limited. However, though the number of research investigating EMR effect is limited findings are confirming EMR effect on plants [3-5]. Among the literatures the influence of EMR on growth parameters have being studied only for seedlings and non-vascular plants except a study on alfalfa plants [6].

Therefore, we investigated how EMR influence on elongation rate of *Myriophyllum aquaticum*. A novel optical interferometry method named statistical interferometry technique (SIT) [7-10], which permits real time growth measurements with very high sensitivity in the order of sub-nanometer, was applied to measure the effect of EMR on the *M. aquaticum* plant. Two points of the *M. aquaticum* stem was illuminated by laser beams and resultant random interference pattern was observed with a CCD camera and it was used as the primary object of determining the elongation of the stem (Fig. 1. a). The elongation rate of the plant was determined at an interval of 0.5 sec. The relative elongation rate (RER) (nm mm^{-1} s^{-1}) between two laser points (*d*) was calculated on elongation over a period *t* of 5.5 sec using following formula (RER = elongation/*td*). RER of plants are rapidly fluctuating (Fig. 2). The standard deviation of RER can be used as a measure in fast assessment of plant vitality in relation to environmental changes [8-10].

M. aquaticum plants with emergent length around 20 cm were used for the present study. RER were recorded continuously for one hour, prior to and after EMR exposure, respectively. After pre-EMR data acquisition plants were brought in to EMR treatment and exposed to 2 GHz EMR at 1.41 Wm^{-2} power density for one hour, (Fig. 1. b)then the post-EMR RER was recorded. Prior to each measurement plants were subjected to 1.5 hours stabilization period. Control experiment was carried out with same procedure except the EMR exposure. All the experiments were repeated for three times.

It was revealed that the EMR exposure caused reduction in standard deviation of GRF of *M. aquaticum* by 51±15 % and it was statistically significant ($P<0.05$, two independent sample T-test). The control test exhibited only 11±6 % difference which was not significant ($P>0.05$)(Fig. 3). Therefore, EMR can induce physiological changes in plants by such a short exposure, and even such a slight effect could be detected with the current highly sensitive technique of SIT.

In conclusion, the reduced SD of RER is consistant with reduced SD of electric potential of *M. aquaticum* observed after exposing to 2 GHz EMR in our further study (data not presented). The induced oxidative stress on plants due to EMR exposure could be the reason to reduced SD of RER. Further, SIT offers high environmental sensitive measurement that has the capability of providing new insights on the dynamics of plant elongation processes at sub nm accuracy.

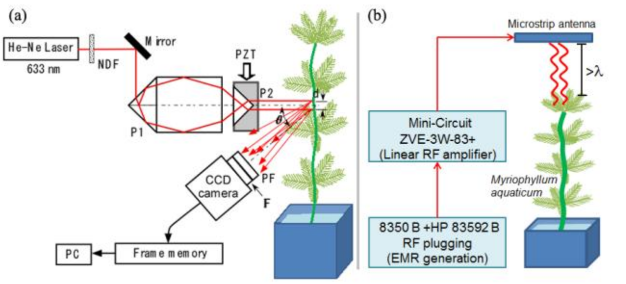

Fig. 1 (a) Optical system for SIT measurement. **(b)** EMR exposure system.

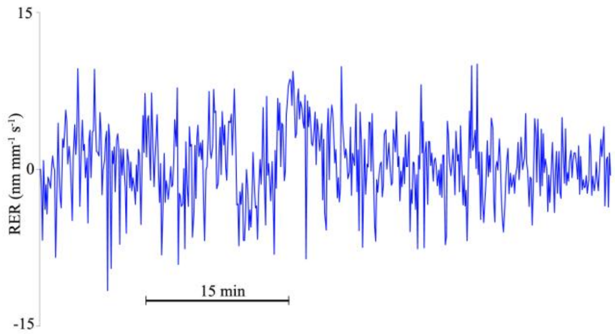

Fig. 2 Fluctuation of RER over time.

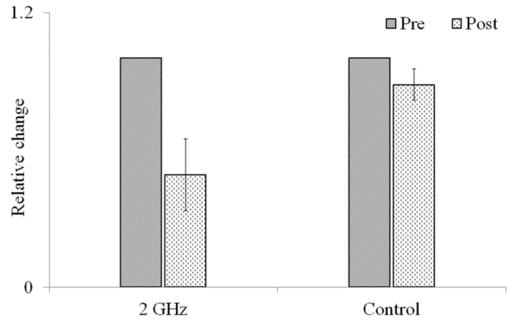

Fig. 3 Relative change of SD of post-EMR exposure RER from pre-EMR exposure. RER of *M. aquaticum* stem. “Pre” and “Post” represents SD of pre-EMR and post-EMR exposure respectively. Error bars represent standard deviation.

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