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PHYSIOLOGICAL RESPONSES IN PLANTS INDUCED BY ARTIFICIALLY GENERATED EMF VECTOR POTENTIAL

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Abstract. The theoretically suggested eigen activity of EMF vector-potential (VP) was checked up through finding out its plausible bioactivity in relation to living plant objects. The stimulating effects of steady-state artificially generated by toroidal emitter VP of magnetic field on *Taraxacum officinale* dormant or germinated seeds and on *Avena sativa* coleoptiles are registered. The modulation of photosynthetic activity of underwent to VP emission *Hibiscus rosa-sinensis* plants in terms of its chlorophyll red fluorescence was shown as well. The findings support the theoretical premises regarding an eigen physical reality of VP.

Introduction

Since Y. Aharonov and D. Bohm [*Aharonov and Bohm,* 1959] publication the VP have not been be treated as mathematical abstraction only and a possible role of EMF vector-potential (VP) as an eigen physical reality capable to self-acting in physical world were widely discussed. Its cosmic role as a plausible physical agent responsible for the solar-terrestrial links so called "Velkhover cosmic phenomenon" [*Chizhevsky*, 1963] was considered also. A number of experiments which would reveal the biophysical role of VP were proposed. A priory suggested physiological reactions of vascular plants on the local disturbances of the background VP have been investigated in accordance with ideas putted forward by K.A. Trukhanov [*Trukhanov*, 1984]. To find out the plausible effects of VP related to stationary magnetic fields its generator was constructed according to K.A. Trukhanov recommendations. In experiments the so called "doughnut coil" i.e. toroidal solenoid formed by about 1000 copper wire turns under steady-state direct current amperage varied within 0,7 - 0,9 amp was used.

Biological objects and methods

The vascular plant living objects, namely seeds, juvenile coleoptiles and matures organisms of oat (*Avena sativa)*, dandelion *(Taraxacum officinalle)*, *Hibiscus rosa-sinensis* plant, var. "Sunny Athene" were used. To detect the plausible bio effects of emitted VP the various physiological reactions of nearby plant objects and different living stages were considered. First of all, the VP field generation effects on the most fast development stages, namely on the seeds germination were investigated. In these case the experimental cohorts dry of water imbibed germinated seeds were daily underwent 4 h exposure nearby VP emission. The control cohorts of the same seeds bunch were took away 6 m apart. The screening to VP susceptibility was carried out at the various structure levels of living systems, among which the photosynthetic apparatus (PSA) of native chloroplasts was checked out. The function of PSA is based on the coordinated work of two connected photo systems (PS) intermitted by electrons transport chain and charged membrane-protein complexes which as whole suggests its susceptibility to external EMF or to potentials change. To explore the question the non invasive method of chlorophyll red fluorescence measurements with PAM-100 «WALZ, Effetrich» technique was used. In experiments the PS II quantum yields: Y(II), Y(NO), Y(NPQ) of native plant leaf blades were registered previously (control) in terms of kinetic light induced curve run and the same blades second run after those were undergone to 1 h VP exposure provided location ones within 10-20 cm around generator center. Y(NPQ) and Y(NO) – are quantum yields of regulated and of nonregulated energy dissipation in PS II, respectively. Effective PS II quantum yield Y(II) is calculated accordingly to [*Genty et al*., 1989] by formula: Y(II) = (Fm'- F)/Fm', where F and Fm the leaf fluorescent yield and maximum fluorescent yield of illuminated samples, respectively. A given sample can show an infinity of various Y(II) values, depending on the state of illumination at the very moment when the saturation pulse is applied. A unique state is given after dark adaptation when the effective PS II quantum yield is maximal. In principle, a quantum yield may vary between 0 and 1. If, for example Y(II) = 0,5 this mean that one half of the absorbed quanta is dissipated into heat and fluorescence. The sum of all quantum yields always amounts to 1. Based on the work [*Kramer et al*., 2004] two other types of PS(II) quantum yield can be defined (NPQ) and Y(NO) adding up to unity with photochemical quantum yield: Y(II) + Y(NPQ) + Y(NO) = 1.

Results and discussion

The preliminary daily 4 h VP exposures of *Taraxacum officinale* seeds since the start of their water imbibe resulted in marked acceleration of their germination as compared to control seeds, incubated in the same time by 6 m off the

VP emitter, Fig. 1. The daily exposure of *Taraxacum officinale* seeds were followed by average acceleration of their averaged germination rate as compared to the control cohorts up to 10-20 per cent.

The preliminary 4-5 h VP daily exposure of both dry 100 seeds C1-C3 cohorts each and the germinated ones resulted in rise of intensity seeds germination experimental V1-V3 cohort as compared to control ones, as well Fig. 2. The same experiments were conducted with other plant species seeds which showed qualitatively comparable results. The stimulation effects were registered on the level of whole and yet formed plant organisms. To ease the compare the sizes of different organisms in plant physiology so called cereal coleoptiles test is ordinary used. As an experimental object the oat *Avena sativa* plant species have been used.

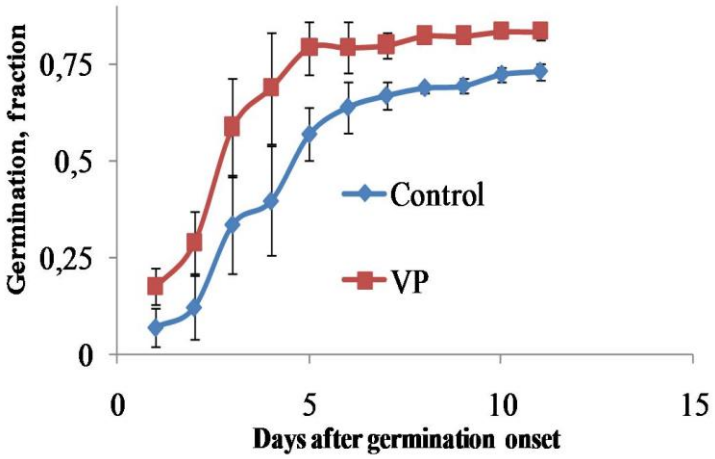

Figure 1. Seeds germination curves for the control and underwent to VP emission *Taraxacum officinale* water imbibed seeds, respectively.

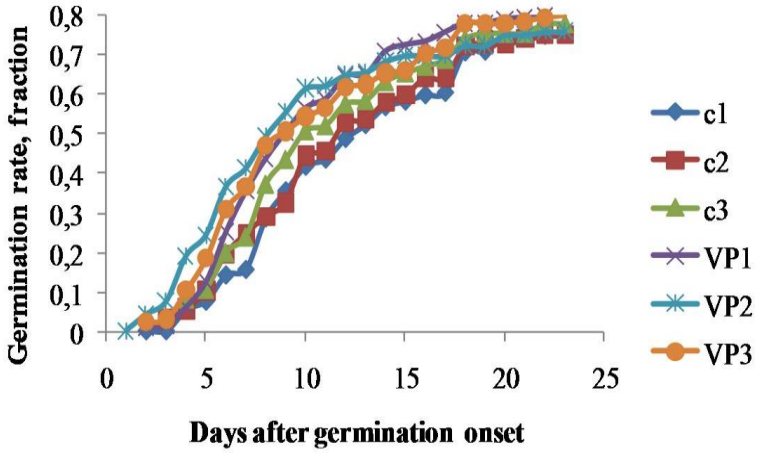

Figure 2. Germination curves for the three control (C1-C3) and three (VP1-VP3) underwent to preliminary VP emission *Taraxacum officinale* dormant seed cohorts of 100 seeds each, respectively.

The effects of VP exposures were registered on the wholly formed plant organisms. The comparative results for the both control *Avena sativa* coleoptiles cohorts with experimental ones underwent a week 4-5 h daily VP exposures for the coleoptiles length distribution are presented on Fig. 3. The germinated seeds exposures followed by the acceleration of the juvenile oat plants growth.

The PSA and photosynthetic functions are highly susceptible to environment, so we have investigated the light induced active activity of PSA under exposure to generated VP in comparison with its work under background environment. The very sensitive and absolutely noninvasive methods of the leaf blade red fluorescence registration were used in terms of light induction curves. The experimental plants have been affected to VP exposure for 4 min during the registration of light curve and 1 h before that. The typical results of the VP photosynthetic effects obtained in terms of chlorophyll fluorescence light induction curve running for the *Hibibiscus* leaf blades are shown on the Fig. 4.

As it seen at Fig. 4, the VP exposure of experimental plants resulted in slight elevation of PS II quantum yield Y(II) after starting of actinic illumination by 10-15% and rise of regulated absorbed energy transformation presented by Y(NPQ) curve as well. The markedly observed drop in the nonregulated energy dissipation Y(NO) for the first 5-6 min of light induction curve running was found also which points out on more effective utilization of absorbed light energy in PS II of PSA.

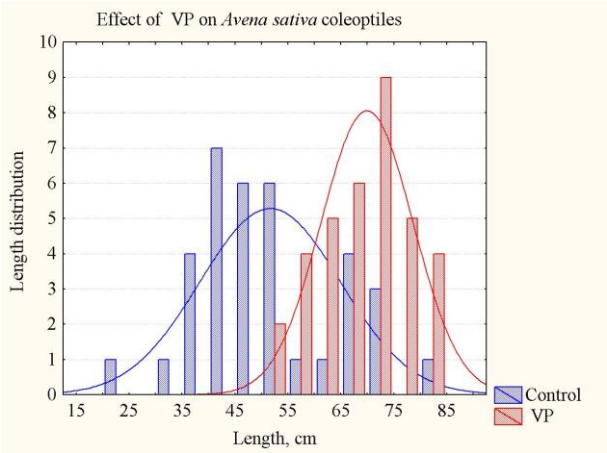

Figure 3. Length distribution of two week age plants for the control and VP exposure underwent *Avena sativa* seed cohorts.

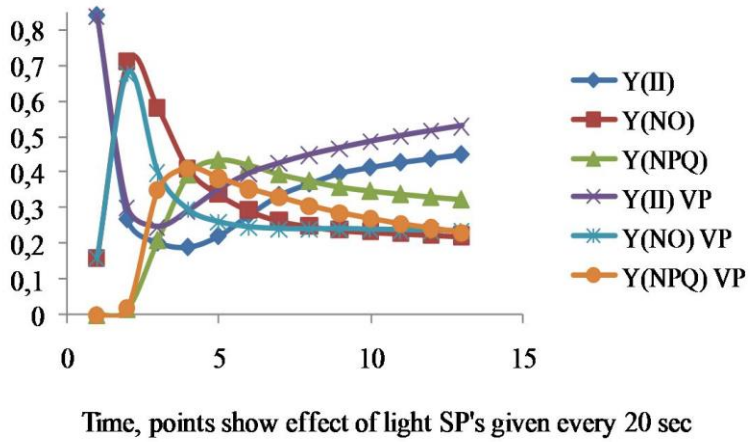

Figure 4. Effect of 1 h VP generation on *Hibiscus rosa-sinensis* plant PS II quantum yield leaf blade parameters. The two light curves of control plant blade running and experimental one underwent emission, marked by VP, are presented, respectively. Points represent effects of respective light saturation pulses.

Conclusions

As a whole summed results show the external VP effects on dormant and germinated seeds stimulation, on growth stages in the early plant morphogenesis as well. The slight stimulation of photosynthetic function in flowered arboreal plants was found also. It is noteworthy to mark, that the effects of VP was registered provided turning up the PS II induction light and hence starting maximal current fluxes through electron transport chain of PSA. As a result 10-15% elevation in effectiveness of PS II primary acceptors reduction under action of artificially generated VP of MP produced steady-state direct current was observed. The difference between photosynthetic parameters was retained for 2-3 days at least. The mechanisms of the effects found unclear now and are yet expected to be elucidated. Nevertheless, the results obtained explicitly point out on the local physiological activity of artificially emitted VP of steady-state magnetic field as well as show its eigen physical reality as it was predicted earlier.

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