THE EFFECT OF MAGNETIC LIQUIDS IN SOME TREE SEEDLINGS

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Abstract: The seedlings of two tree species, the black poplar hybrid (*Populus canadiensis* Moench.) and the pedunculate oak (*Quercus robur* L.), among the most important for the temperate region, were treated with various concentrations of oil-ferrofluid based on natural hydrocarbons. The experiment has revealed the ferrofluid influence on the assimilatory pigments as well as on the nucleic acids (spectral measurements) in young plantlets aged of 3 months. It was found that the levels of assimilatory pigments are generally diminished though the ratio chlorophyll a/chlorophyll b is generally enhanced for ferrofluid samples suggesting the seedlings sensitivity to the chemical and magnetic stimuli consistent with the ferrofuid addition. The LHC II system (Light Harvesting Complex II) sensitivity to external factors might be associated with the ferrofluid influence on the young seedlings photosynthesis.

INTRODUCTION

Since tree species from the Earth temperate regions are more and more threatened by pollution and atmosphere adversity in the last decades, this study was designed to reveal the influence of small aliquots of iron and hydrocarbons on the young seedlings of oak and black poplar hybrids. Beside its relative role of local pollutant, iron is a major constituent of soils with iron contents between 0.5 and 5 percent, depending on parent rocks and soil type. Despite its general abundance, iron concentrations in aerobic soil solutions are usually very low (due to the low solubility of iron oxides, oxyhydroxides, and hydroxides that limit dissolved iron concentrations, particularly in neutral or alkaline soils), so that the artificial increase of its concentration may represent a source of toxicity. It was shown that an efficient mechanism of iron acquisition by microorganisms and graminaceous plants involves the release of iron complexing compounds, called siderophores. Plants may benefit from the presence of some growth stimulatory bacteria since these microorganisms can produce iron complex combinations (under iron-limited conditions) called siderophores - that can be internalized by plant root cells. (1). The ability of the fungus *Rhizopus arrhizus* to produce chelators such as the so called siderophore rhizoferrin was searched by Yehuda et al. (2) who focused on the mechanisms by which some graminae species utilize iron from phytosiderophores. Sherker et al. (3) studied the plant-produced chelators called phytosiderophores that are excreted directly to the rhizosphere. Iron uptake by barley and corn plants grown in nutrient solution was found to run parallel to the diurnal rhythms of phytosiderophore releasing via an indirect mechanism of ligand exchange between the ferrated microbial siderophore and phytosiderophores, which are then taken up by the plant. In the experiment presented inhere, the controlled supply with hydrocarbon ferrofluid was chosen to study its effects upon the young seedlings.

MATERIALS AND METHODS

Since tree species from the Earth temperate regions are more and more threatened by pollution and atmosphere adversity in the last decades, this study was designed to reveal the influence of small aliquots of iron and hydrocarbons on the young seedlings of oak and black poplar hybrids. Beside its relative role of local pollutant, iron is a major constituent of soils with iron contents between 0.5 and 5 percent, depending on parent rocks and soil type. Despite its general abundance, iron concentrations in aerobic soil solutions are usually very low (due to the low solubility of iron oxides, oxyhydroxides, and hydroxides that limit dissolved iron concentrations, particularly in neutral or alkaline soils), so that the artificial increase of its concentration may represent a source of toxicity. It was shown that an efficient mechanism of iron acquisition by microorganisms and graminaceous plants involves the release of iron complexing compounds, called siderophores. Plants may benefit from the presence of some growth stimulatory bacteria since these microorganisms can produce iron complex combinations (under iron-limited conditions) called siderophores - that can be internalized by plant root cells. (1). The ability of the fungus *Rhizopus arrhizus* to produce chelators such as the so called siderophore rhizoferrin was searched by Yehuda et al. (2) who focused on the mechanisms by which some graminae species utilize iron from phytosiderophores. Sherker et al. (3) studied the plant-produced chelators called phytosiderophores that are excreted directly to the rhizosphere. Iron uptake by barley and corn plants grown in nutrient solution was found to run parallel to the diurnal rhythms of phytosiderophore releasing via an indirect mechanism of ligand exchange between the ferrated microbial siderophore and phytosiderophores, which are then taken up by the plant. In the experiment presented inhere, the controlled supply with hydrocarbon ferrofluid was chosen to study its effects upon the young seedlings.

RESULTS AND DISSCUSIONS

The average values of the chlorophyll a and b contents from the leaves of the pedunculate oak seedlings (*Quercus robur* L.) treated with ferrofluid aliquots are given in figure 1. One can see that, mainly, an inhibitory effect was recorded, except the sample treated with 20 microl/l, where the content of chlorophyll a is slightly increased in comparison to the control. The same thing is valuable also for the content of total carotenoid pigments (fig. 2).

As in the case of chlorophyll a, the concentration of 60 microl/l led to the most considerable diminution (about 40%) in comparison to the control. However, the biochemical parameter that is the most important for the plant physiology is the ratio chlorophyll a/b and this one is enhanced for the most ferrofluid concentrations tested in this experiment (fig. 3). So, in spite of the absolute values of chlorophylls and carotenes contents, the relative value of the main assimilatory pigment (chlorophyll a) to the chlorophyll b (a secondary pigment) indicates a positive influence of the ferofluid upon the young seedlings of pedunculate oak.

In the study of young saplings of black poplar hybride (*Populus canadiensis* Moench.) the

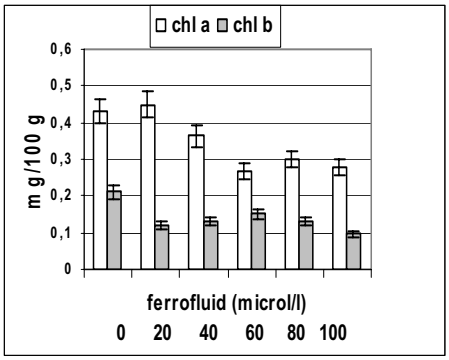

Fig. 1. The contents of chlorophyll a and chlorophyll b in oak seedlings

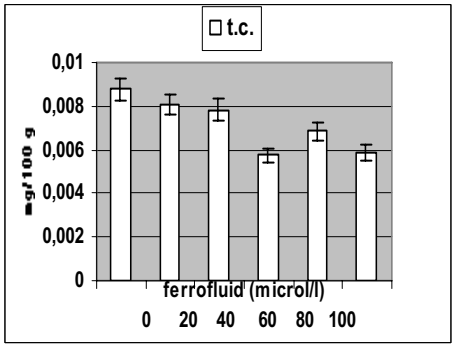

Fig. 2. Total carotenoid pigments in oak seedlings

results obtained for the spectrophotometric assay of photosynthetic pigments are presented in figures 4-5.

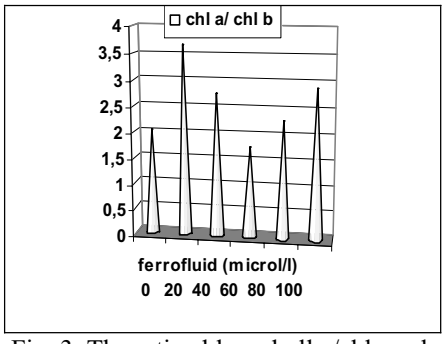

Fig. 3. The ratio chlorophyll a/chlorophyll b in oak seedlings

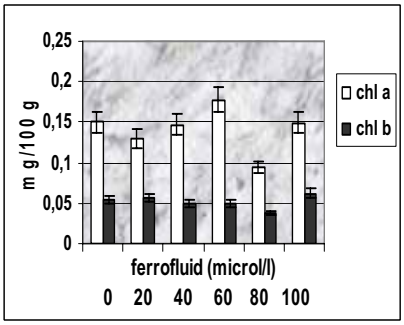

Fig. 4. The contents of chlorophyll a and b in black poplar hybrid

The absolute values of all three assimilatory pigments are lower (about twice) than for the other tree species presented above. The absolute values of chlorophyll a, chlorophyll b and caroteniod pigments are smaller or equal to that of the control sample except one ferrofluid concentration – in the case of the black poplar the concentration of 60 microl/l (figures 4-5)

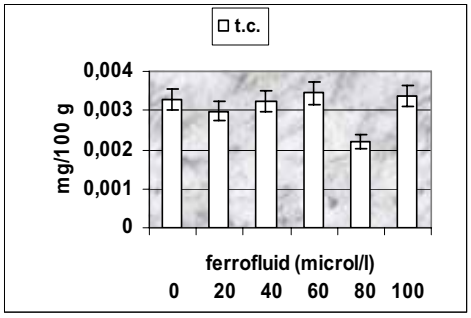

Fig. 5. The total carotenoid pigments in the black poplar hybrid

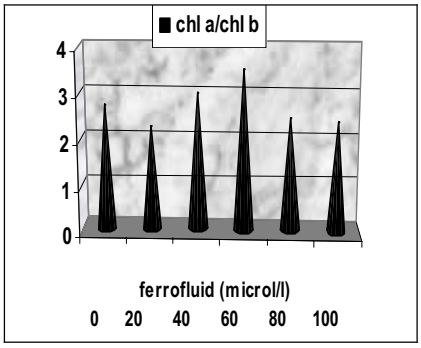

Fig. 6. The ratio chlorophyll a/b in the black poplar hybrid

The chlorophylls ratio (chlorophyll a/b) suggests a stimulatory effect for the concentrations of 40 and 60 microl/l (fig. 6). Considering that the ratio chlorophyll a/b is the most significant biological parameter that reflects the physiological response of the photosynthetic systems I and II, the authors might underline the stimulatory effect of small concentrations of ferrofluid in both tree species (though no distinct correlation between the ferrofluid concentration and the ratio chlorophyll a/b was emphasized). One might assume that the iron oxide supply could have a certain effect due to the iron itself as well as due to the magnetic properties of the iron oxide particles within the ferrofluid since most of them have dimensions comparable to the magnetization domains. The sensitivity of other young tree seedlings (black locust) to external factors of magnetic nature (microwaves) was discussed also in (4), where the putative damage of chlorophyll biosynthesis is assumed too. The situation of carotenoid pigments in oak seedlings has emphasized the inhibitory ferrofluid effect on the biosynthesis of the secondary assimilatory pigments. In the case of poplar seedlings the carotenoid pigment content was not significant modified by ferrofluid addition. Corroborating this issue with the smaller modification of the ratio chlorophyll a/b in poplar seedlings in comparison to the oak ones the authors assume the lower sensitivity of young poplar plants to ferrofluid administration in comparison to that of oaks of the same age. In fig.7 the comparative situation of the nucleic acid contents is presented for the two studied species. There is a significant inhibitory effect in the case of poplar seedlings suggesting that possible negative influences on the plant growth are expected, while for oaks no significant modifications have been noticed.

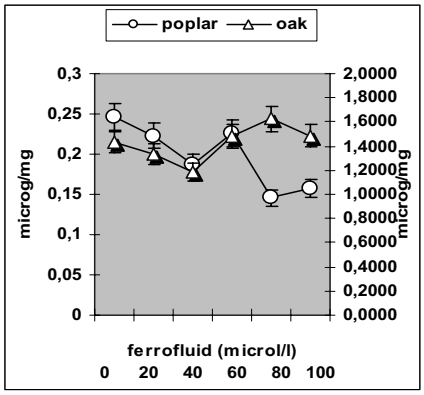

Fig. 7. Nucleic acid content in oak and poplar

CONCLUSIONS

We might say that ferrofluid supply represented a source of iron and, possibly, magnetic energy that influenced in different ways the young plantlets of the two tree species investigated inhere. The biosynthesis of chlorophyll is considerably stimulated in oaks (where the biosynthesis of nucleic acids is non-significantly affected) while in poplars the chlorophyll biosynthesis is only slightly stimulated and the nucleic acids content is diminished. Further investigations, deeper and more specific, are intended for the next stages of this research

REFERENCES

(1) De Weger, L. A., Van Arendonk, J. J., Recourt, K., Van der Hofstad, G. A., Weisbeek, P. J., &Luhtenberg, B., 1988. *J. Bacteriol.* 170 (10), 4693–4698
(2) Yehuda, Z., Shenker, M., Romheld, V., Marschner, R., Hadar, Y. & Chen Y., 2001. *Plant Physiology*, 112 (3) 1273-1280
(3) Shenker, M., Fan, T. W. M.& Crowley, D.E., 2001. *Journal of Environmental Quality,* 30, 2091-2098
(4) Sandu, D.D., Goiceanu, C., Creanga, I., Ispas, A., Miclaus, S. & Creanga, D.E., 2005. *Acta Biologica Hungarica*, 56 (1-2), 109-117.

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