AN ELECTROPHYSIOLOGICAL APPROACH TO DETECTION AND EVALUATION OF STRESS RESPONSE IN TREES

Robb William, Matoušková Marie, Urban Josef

Mendel University in Brno / Faculty of Forestry and Wood Technology

INTRODUCTION

Stressful conditions can reduce a tree's ability to produce energy as well as force the tree to divert energy from growth, flowering, and fruiting to defence (Cotrone, 2022). Abiotic stress response in trees can be difficult to detect because the underlying causes can take many years to manifest in visible ways. This is especially true for the less visible tree parts such as the root system. Electrical signals play a key role in rapid transmission of information between roots and shoots. (Gora et al., 2015) state that it is clear that electrical properties vary among tissues, leaves differ electrically from stems, and stems differ electrically from roots. However, such patterns remain underexplored. In this study hypoxic and drought stress have been applied via changes in soil bulk density and soil moisture levels. Measurements of the bioelectrical potential between roots and stem provide the basis for an electrophysiological approach to stress detection and evaluation. As stated by Volkov (2012) "plant electrophysiology is the foundation of discovering and improving biosensors for monitoring the environment ...".

MATERIAL AND METHODS

Research plots containing three different tree species, have been established at the University Forest Enterprise Masaryk Forest of Křtiny. Oak, Beech, Spruce trees have been subjected to drought stress and hypoxic stress. Additionally, five control trees of each species have been monitored in similar climatic conditions minus the stressors. Key methodology has included the following:

a) Daily measurements of electrical conductivity-EMS dataloggers connected with specially adapted needle electrodes (Fig. 1)

b) Weekly measurements of root electrolyte leakage-GLF 100 conductivity meter (Fig. 1)
c) Weekly measurements of spectral reflectance-PSI PolyPen

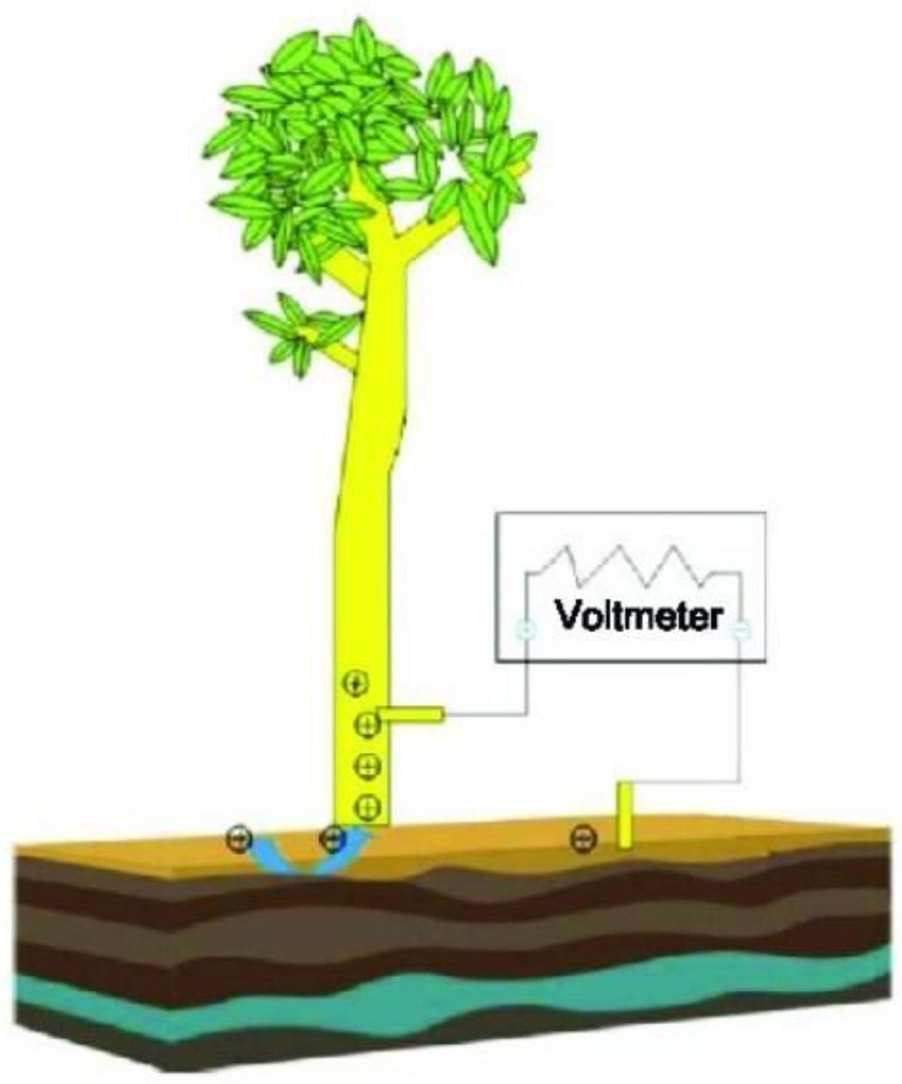

Fig.1: Schematic diagram of tree-energy acquisition representing the production of an internal electrical current via its metabolism (Shuo Zhang, 2019)

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RESULTS AND DISCUSSION

This study shows from preliminary results that there are changes in bioelectrical potential, root electrolyte leakage and spectral reflectance values due to the influence of abiotic stress in trees. It can be seen from one example in Fig. 2 that, based on preliminary results, mechanical wounding occurring on T2 (Fig. 3) has resulted in a distinctly lower reflectance value in comparison to similar undamaged trees.

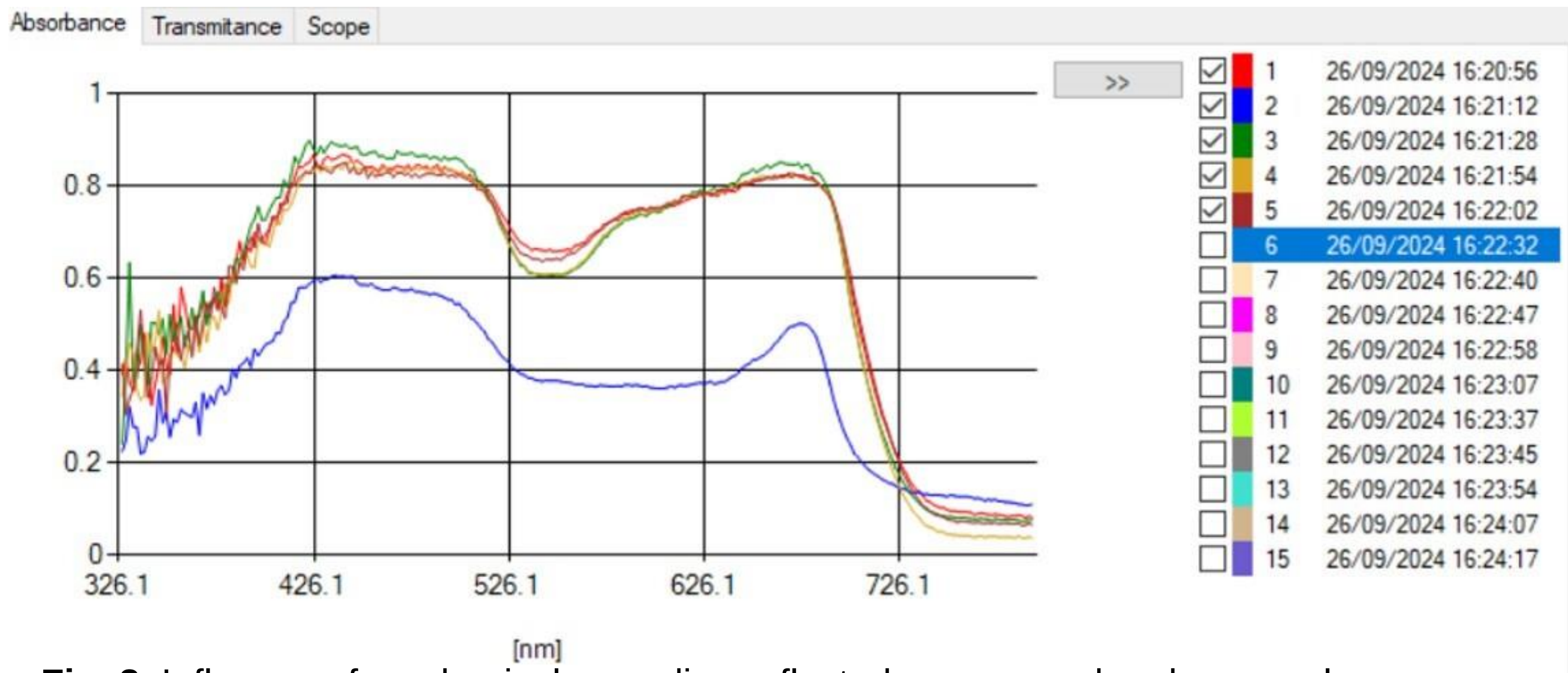

Fig. 2: Influence of mechanical wounding reflected on a poor absorbance value seen on sample T2

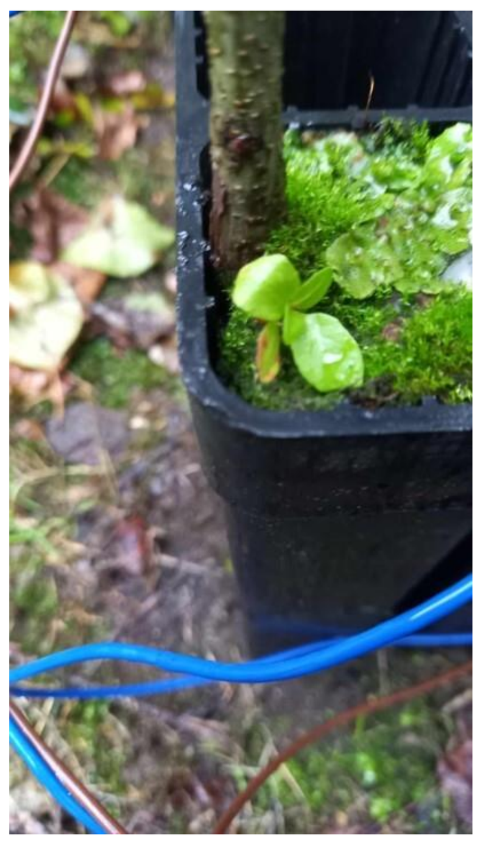

Fig. 3: Stem damage visible on T2 (bottom left against container)

Other abiotic stressors such as drought and hypoxia have shown variance in electrical conductivity with increased root electrolyte leakage over time. This includes preliminary data related to bioelectrical potential measurements as can be seen from Fig. 4.

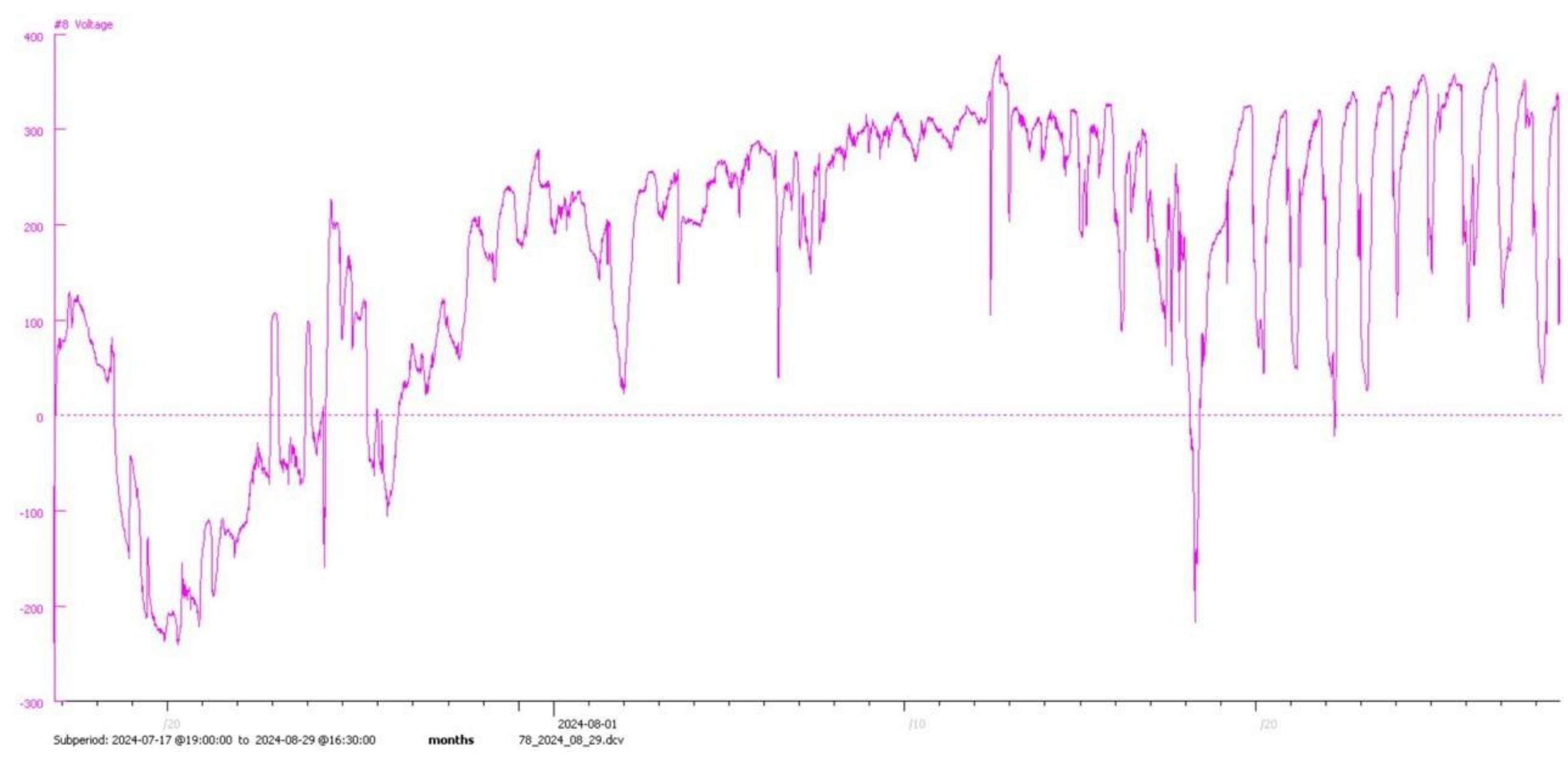

Fig. 4: Increased variance in bioelectrical potential due to the effect of flooding on sample T8

CONCLUSIONS

The preliminary data indicate that with further work an electrophysiological approach to detection and evaluation of stress response in trees is possible. For example, this will require development and establishment of known species datasets.

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