

BRIEF COMMUNICATION

Leaf Respiration: Possible Cause of Stimulation after Low Temperature Treatment

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Abstract. Uncoupling of oxidative phosphorylation by 2,4 dinitrophenol stimulated leaf respiration rate measured as CO_2 production or O_2 uptake after low temperature treatment.

A few papers reported the increase in leaf respiration rate (R_D) following low temperature treatment (CREENCIA and BRAMLAGE 1971, WILSON 1978, TODARIA 1986). A possible cause of that was attributed to uncoupling of oxidative phosphorylation (CREENCIA and BRAMLAGE 1971), the increased leakage of ions (POWELL 1969) and the reduction in ATP contents (WILSON 1978, STEWART and GUINN 1969). However, WILSON (1978) did not find any uncoupling of oxidative phosphorylation at chilling temperature. Thus the reason of R_D increase after low temperature treatment is still uncertain. This study was aimed at assessing the role of uncoupling of phosphorylation by 2,4 dinitrophenol (DNP) in the R_D increase.

R_D was measured in a Warburg apparatus (*cf.* TODARIA 1986 for details). The top mature leaves were cut into small pieces and exposed in Warburg flasks with wet filter paper and 0.3 cm^3 KOH. For low temperature treatment the flasks with leaf samples were immediately after cutting transferred to prefixed temperature in a refrigerator. After a desired exposure, the flasks were conditioned at room temperature for 5 min, and R_D was measured.

In a preliminary experiment with DNP application, better results were obtained with infiltration than soaking the material. The effective concentrations of DNP which gave maximum stimulation of R_D in leaves of *Canarium oleosum* and *Pachira insignis* were 0.4 mM and 0.1 mM, respectively. These concentrations were used in subsequent measurements of R_D after low temperature treatment. The control was infiltrated with water. These

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treatments were followed by manometric measurements of O_2 uptake, or measurements of CO_2 evolution by direct Warburg method using flasks without hydroxide.

In both species, *Pachira insignis* and *Canarium oleosum*, the stimulation of R_D measured as O_2 uptake caused by low temperature treatment was suppressed by DNP treatment (Fig. 1A, B). The degree of R_D stimulation and decline by DNP treatment were different in the two species. Low temperature conditions also stimulated CO_2 evolution rate in *P. insignis* but the stimulation was not observed in *C. oleosum* (Fig. 1C, D). However, DNP treatment suppressed CO_2 evolution in both species. Low temperature can rapidly induce changes in plants depending upon the duration of low temperature treatment and previous history of plant species. The cause of these rapid changes may arise from physical and biochemical changes at low temperature. It has been reported that oxidation rates of mitochondria fall quickly at chilling temperature (LYONS and RAISON 1970), which results in the reduced energy generation.

Stimulation of respiration may results from uncoupling of oxidative phosphorylation at low temperature (CREENCIA and BRAMLAGE 1971). The results of this investigation also suggest that uncoupling of oxidative phosphorylation does take place (Fig. 1). It seems that at low temperature phosphorylation is uncoupled and the severity of injury depends on the duration of the exposure and on temperature to which cells are subjected. WILSON

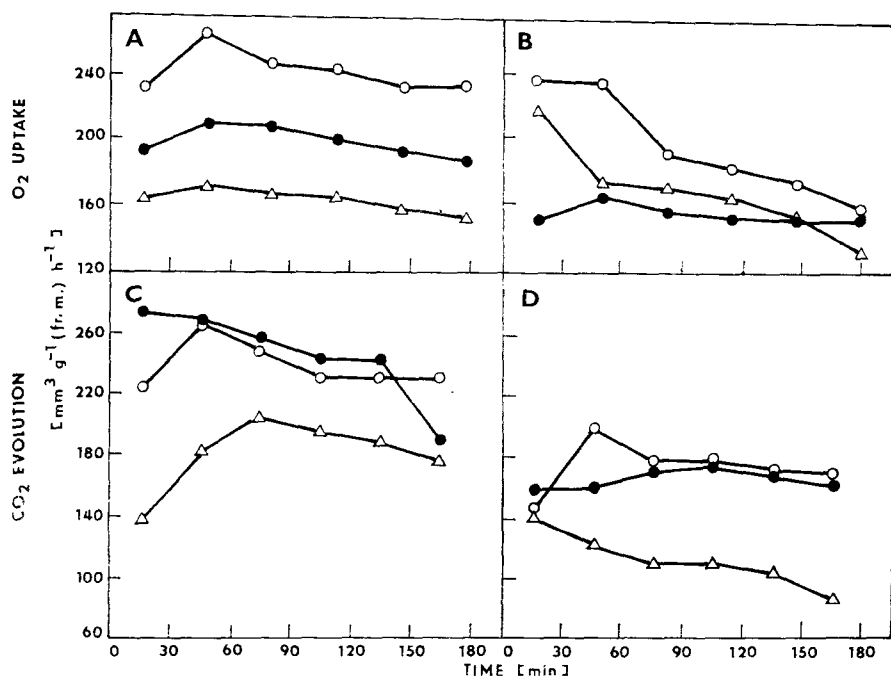


Fig. 1. Effect of low temperature treatments on O_2 uptake (A, B) and CO_2 evolution (C, D) rates in *Pachira insignis* (A, C), and *Canarium oleosum* (B, D). ● — control; ○ — low temperature treatment; △ — low temperature + DNP treatment.

(1978) did not observe uncoupling of oxidative phosphorylation which may have been due to the treatment of tissues in DNP before low temperature treatment.

Carbon dioxide production also increased after low temperature treatment in *P. insignis* and declined in low temperature plus DNP-treated tissues of both the species (Fig. 1C, D). This supports the argument that the uncoupling of oxidative phosphorylation at low temperature did take place in both the species. On the other hand, it is probable that the decrease in R_D after low temperature plus DNA treatment may also result from the fact that after low temperature treatment, membrane permeability is increased and due to this more DNP penetrates into cells. This ultimately may bring down respiration rate.

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BOOK REVIEW

UTILIZATION, TREATMENT, AND DISPOSAL OF WASTE ON LAND. Proceedings of a workshop held in Chicago, IL, 6–7 Dec. 1985. — Soil Science Society of America, Inc., Madison, 1986. — 318 pp., paperback US \$ 21.00 + 75 c outside.

These proceedings consist of invited papers by well-known experts working in various branches of this serious problem. In the brief introduction A. L. Page, C. Lue-Hing and A. C. Chang review the concepts of present day land application and waste utilization system. The following 22 papers are grouped into four sections entitled: 1. Land Treatment of Sewage Effluents with Minimum Pretreatment Large Flows: Land Application (6 papers); 2. Small Flows: Onsite and Clustered Systems (8 papers); 3. Land Applications of Municipal Sludges (4 papers) and 4. Hazardous Waste in the Soil Environment (4 papers). The conclusion by R. C. Loehr and H. M. Alharthy discusses the future role of soil scientists in the management of wastes.

The book as a whole draws attention to the use of soil in solving society's increasing problem concerning waste disposal and to the role of soil science disciplines in helping to solve this problem economically, i.e. with the minimal possible negative effect on soil quality and plant productivity.