DEPENDENCE OF OSCILLATORY CHANGES IN ELECTRICAL RESISTANCE OF *NITELLOPSIS OBTUSA* CELL MEMBRANES ON THE VEGETATION SEASON

EDWARD ŚPIEWLA

Department of Physics, Technical University of Lublin,
Bernardyńska 13, 20-950 Lublin, Poland

(Received: April 12, 1995. Accepted: October 20, 1995)

ABSTRACT

The dependence of the amplitude of oscillatory changes in the electrical resistance of *Nitellopsis obtusa* cell membranes on the vegetation season of these plants is determined. The measurements were made on third cells from the tips of the plants which showed at least one type of oscillation in the resistance. A clear dependence of the amplitude of the studied changes on the vegetation season, especially on the maturity and rest stages of the plants, was found. These results as well as the observed changes in the characteristics of oscillations in the resistance, caused by sudden changes in the temperature of the cell surrounding, indicate a relationship between the oscillatory behaviour and the intensity of metabolic changes in the cells.

KEY WORDS: *Nitellopsis obtusa*, oscillations in electrical resistance.

INTRODUCTION

During our studies of oscillatory changes in the electrical parameters of *Characeae* membrane cells, it was found (Śpiewla, 1994) that the characteristics of the oscillatory changes in the electrical resistance depend, inter alia, on the individual development stage of the cells. In our earlier works (Skierczyńska et al. 1975, Śpiewla 1983), a clear dependence of the value of the electrical resistance of cell membranes of these plants on their vegetation period was observed. In context of the investigations carried out so far on the oscillatory behaviour of plant cells (Johnsson 1983, Śpiewla and Tokarska 1990, Antkowiak 1992, Tokarska and Śpiewla 1994), the verification whether oscillatory changes in the electrical resistance of cell membranes depend on the vegetation season of the plants appeared interesting. The results presented here form a part of a wide range of investigations being carried out for the last several years and intended mainly to understand the mechanisms of generation of periodic electrical changes and transport changes in the cell membranes of plants.

MATERIAL AND METHOD

Measurements were made for internodal cells of *Nitellopsis obtusa* (Desv. in Lois) J. Gr., of uncorticated species of the *Characeae* family. The plants were collected from the Zagłębie lake and were stored during the measurements in the laboratory in natural lake water. The concentrations of basic ions in the water were as follows: 0.06 mM K⁺, 0.28 mM Cl⁻, 0.01 mM Mg²⁺ and 0.29 mM Na⁺ (pH 7.0 ± 0.2).

The electrical resistance of the membranes of internodal cells and its periodic fluctuations were determined by the four

external electrode method, described in our earlier works (Skierczyńska et al. 1972, 1973). A direct current in the form of rectangular impulses of 0.1 μA strength and 2-4 s duration was used in the experiments. The experimental solution used in the measurement vessels was lake water. For the investigations, third cells from tips of the plants (4.5 to 9.0 cm long) were selected. The measurements were carried out for four series of cells showing oscillations in the periods of the first decade of November and in the third decades of August, September and October.

RESULTS

The results obtained for 38 cells (some of which showed oscillations of second and third types) selected from about 130 samples are presented in Table 1. The obtained numerical data are averages of the data obtained from all cells in particular series of measurements (their numbers are given in parentheses). In addition to the average amplitudes of periodic changes in resistance, the scatter and its value for different cells and the magnitudes of their relative changes with respect to the values of average unitary resistances of the membranes of the investigated series of the cells.

The results obtained for the series 4 of the cells showing 15-min type oscillations, in the aqueous environment of which the temperature was suddenly changed from 18.5°C to 28°C, behaved also in a similar manner (Table 2). In the latter measurements, the average values of the periods of oscillatory fluctuations in resistance before and after the increase in temperature of the environment were also determined.

TABLE 1. Values of amplitude of oscillatory changes in the resistance of membrane of *Nitellopsis obtusa* cells: third from the plant top.

Type of resistance oscillation	Amplitude of oscillation changes in unitary resistance of membrane cells							
	First decade of July 1994		Third decade of August 1994		Third decade of September 1994		Third decade of October 1994	
	(kΩ cm ²) Range(kΩ cm ²)		(kΩ cm ²) Range (kΩ cm ²)		(kΩ cm ²) Range (kΩ cm ²)		(kΩ cm ²) Range (kΩ cm ²)	
"1 h"	6,0 (6)* 3,2 - 9,0		6,1 (4) 2,5 - 10,0		5,1 (4) 4,0 - 7,2		5,9 (2) 5,5 - 6,3	
	Relative changes: 32,6%		Relative changes: 31,0%		Relative changes: 20,5%		Relative changes: 17,2%	
"15 min"	5,8 (5) 4,3 - 9,5		6,6 (6) 2,7 - 9,2		6,2 (5) 4,1 - 7,6		5,9 (1) -	
	Relative changes: 29,0%		Relative changes: 30,5%		Relative changes: 24,0%		Relative changes: 18,0 %	
"3 min"	5,3 (5) 3,9 - 6,4		4,9(4) 4,1 - 5,6		5,4 (3) 4,5 - 6,0		4,6 (3) 4,2 - 5,1	
	Relative changes: 24,5%		Relative changes: 22,0%		Relative changes: 23,0%		Relative change: 12%	

*The examined cell numbers are given in brackets.

DISCUSSION

The data listed in Table 1 reveal that the amplitude of oscillatory fluctuations in resistance, like the value of the unitary resistance of cell membranes (Skierczyńska et al. 1975), practically remain unchanged during growth of the plant. However, this amplitude clearly decreases during plant development (when its relative change decreases from over 28% to about 22% in September) and during its rest period (to about 15% at the end of October). The activity of generation of spontaneous oscillatory changes in the conductance of membranes in mature cells and especially in those existing in the state of rest in relation to the cells of developing plants. Changes in the conductance of mature cells are characterised by poor reproducibility and stability. The magnitude of the period of oscillation also increases in this stage of vegetation.

The result of the observation of changes in the characteristics of oscillation in the conductance after a rapid change in the temperature of environment seems interesting. An increase in the temperature by 9.5°C leads to an increase in the

average value of the relative change in the amplitude of oscillation of resistance by about 5% and to a decrease in the average period by 28.5%. However, in view of the preliminary character of the latter investigations, it may be said that the value of the period of oscillation of resistance caused by changes in temperature of the environment changes significantly.

The results obtained, corroborate the view that the relationship between the intensity of oscillatory changes in electrical resistance of cell membranes of the investigated plants and the stage of their growth, and consequently their metabolic activity, appears evident. From here also follows the conclusion that a close relationship between oscillatory changes in the concentration of flux of potassium ions flowing through the cell membranes and changes in the resistance of these membranes exists (Antkowiak 1992, Paszewski and Śpiewła 1986, Fisahn et al. 1989). However, the formulation of more precise and unequivocal conclusions will be possible after extending the above investigations to a significantly higher number of cells and to other plants.

TABLE 2. Alteration of unitary resistance of the membrane of *Nitellopsis obtusa* cells after a rapid temperature change from 18,5°C to 28°C.

Cell no.	Type of oscillation	18,5°C			28,0°C		
		Amplitude of oscillatory changes in the resistance (kΩ·cm ²)	Relative changes in the resistance (%)	Period of resistance oscillations (min)	Amplitude of oscillatory changes in the resistance (kΩ·cm ²)	Relative changes in the resistance (%)	Period of resistance oscillations (min)
1.	"15min"	10.5	29.5	19.0	9.3	34.8	13.7
2.	"15min"	5.7	22.8	13.0	5.8	34.1	9.3
3.	"15min"	7.2	22.9	17.4	6.4	28.0	12.3
4.	"15min"	6.4	23.7	28.6	4.9	26.9	20.9
Mean:		7.4	24.7	19.5	6.6	30.9	14.1

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ZALEŻNOŚĆ OSCYLACYJNYCH ZMIAN OPORU ELEKTRYCZNEGO BŁON KOMÓRKOWYCH
NITELLOPSIS OBTUSA OD OKRESU WEGETACJI

STRESZCZENIE

Określono zależność amplitudy oscylacyjnych zmian oporu elektrycznego błon komórek *Nitellopsis obtusa* od okresu wegetacji tych roślin. Pomiary przeprowadzono na trzecich komórkach od wierzchołków roślin, wykazujących co najmniej jeden typ oscylacji oporu. Stwierdzono wyraźną zależność amplitudy badanych zmian od okresu wegetacji, szczególnie na etapie dojrzewania i "spoczynku" roślin. Dane te, jak też wykryta zmiana charakterystyki oscylacji oporu wywołana gwałtowną zmianą temperatury środowiska komórek, wskazują na powiązanie oscylacyjnych zachowań z intensywnością przemian metabolicznych w komórkach.

SŁOWA KLUCZOWE: *Nitellopsis obtusa*, oscylacje oporu elektrycznego.