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Effect of plant growth regulators on membrane permeability of tomato leaf cells

Wpływ regulatorów wzrostu na przepuszczalność błon komórkowych liści pomidorów

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There are many reports on the effect of plant growth regulators on the rate of transpiration without affecting stomatal behaviour. This has been observed during auxin treatment by different authors (Boysen-Jensen 1935, Player 1950, Michniewicz 1961.

At gibberellic treatment an increase of the cuticular (Sivadijan 1957) and of the total transpiration was observed (Coulombe and Paquin 1959, Michniewicz 1961), however, no effect of gibberellin on the size of the stomatal apertures was found.

It is possible that the changes in transpiration rate in consequence of auxin application are caused by the influence of auxins on the physico-chemical properties of the cell membranes. Some data from literature indicate that such action of auxins is possible (Pohl 1949, 1954, Guttenberg 1955, Müller and Ramshorn 1957).

The lack of correlation between the influence of growth regulators on the rate of transpiration and their influence on stomatal behaviour and also Sacher's (1959) observations show that the causes of changes in transpiration intensity may be traced to the effect of growth regulators on membrane permeability. Sacher's work gives us some indications in this field. He described inhibiting effect of IAA and NAA on the leakage of water and organic and inorganic substances from the leaf cells into the intercellular spaces in *Rheo discolor* and *Mesembryanthemum* sp.

MATERIAL AND METHOD

Tomato leaves of "Karzełek Puławski" and "Mory 33" varieties were used in these experiments. Plants which had been pulled out carefully and washed off rests of soil were put into 5 — 250 ppm solutions of 3-indolylacetic acid (IAA), 2,3,5-triiodobenzoic acid (TIBA), and gibberellic acid (GA) and then kept at 25°C in a luminostat chamber regulated to 12 h light during the day.

Table 1

Electric resistance of IAA, TIBA and GA solutions used in treatment (in k ohms×10)

Solution	Concentration in ppm				
	10	25	50	100	250
IAA	2.545	1.380	0.825	0.538	0.305
TIBA	2.710	2.212	0.926	0.509	0.192
GA	2.235	1.361	0.735	0.431	0.223

Plants treated with IAA and TIBA were examined after 24 h, and in case of treatment with GA after 48 h in order to let GA show its specific effect.

The permeability was determined by means of a conductoscope by the method of Maximov and Vasileva (1949) which was applied later by Vasileva (1953). In this method the permeability is determined on the base of the electric resistance of the solutions obtained by diffusion of low molecular weight substances out of the cells. The electric resistance of these solutions is inversely proportional to the membrane permeability of the cells of the examined tissue.

It can be seen from a comparison of the data shown in Table 1 with those shown in Table 2 that IAA, TIBA and GA solutions used in the treatment of plants have no effect on the electric resistance of the solutions formed as a result of diffusion of organic and inorganic substances out of leaf cells into redistilled water.

The electric resistance of the IAA, TIBA and GA solutions used for the treatment of plants was about 100 times less than the resistance of the dissolved in redistilled water diffusates from the cells.

Therefore, it is obvious that the solutions of the growth regulators had no direct effect on the results of these experiments.

DISCUSSION

The data on the electric resistance of the solutions of the diffusates obtained from tomato leaf cells are shown in Table 2.

It can be seen that IAA in the concentrations from 5 to 50 ppm considerably decreased the diffusion of the low molecular weight substances out of the leaf cells. In spite of the fact that in some experiments the effect of IAA was strongest at various concentrations, this effect occurred within above mentioned limits in nearly 80 per cent of the experiments.

The differences in inhibitory effect of IAA in the particular experiments may be explained by differences in the physiological state of plants, viz., in their age and in the external conditions of plant vegetation prior to the experiments.

Table 2

Effect of IAA, TIBA and GA treatment on membrane permeability of tomato leaf cells
(determined as electric resistance in ohms × 100) *

Variety	Age in weeks	Treatment	Concentration in ppm								Significant differences	
			0 (H_2O)	5	10	25	50	100	200	250	P = 0.05	P = 0.01
Karzełek Puł.	4		3.197	3.557	—	—	**4.660**	3.485	—	—	1.015	1.424
Karzełek Puł.	6		2.190	2.172	—	**2.487**	2.207	—	2.252	—	0.297	0.412
Karzełek Puł.	8	IAA	1.720	**2.176**	—	—	**2.400**	1.730	—	—	0.394	0.543
Mory 33	6		2.480	—	**2.918**	—	2.680	—	—	2.544	0.351	0.484
Mory 33	7		1.972	1.876	**2.148**	—	**2.156**	1.916	—	—	0.141	0.192
Mory 33	8		1.590	—	**2.046**	—	1.597	—	—	1.510	0.287	0.396
Karzełek Puł.	6	TIBA	2.132	—	2.072	2.022	2.104	2.166	—	2.010	0.195	0.264
Mory 33	7		1.853	1.910	—	—	1.863	1.921	1.908	—	0.115	0.156
Karzełek Puł.	4	GA	3.316	3.283	—	3.263	—	3.293	3.176	3.279	0.301	0.422
Mory 33	6		2.336	—	2.256	2.342	—	2.382	2.356	2.316	0.119	0.162

* Thick type indicates differences significant at P = 0.05 in comparison with control (zero concentration).
Underlined thick type indicates differences significant at P = 0.01 in comparison with control (zero concentration).

The results of this paper demonstrate that auxin inhibits the permeability of water and of the substances dissolved in it out of the cells into the surrounding medium. These results confirm the data obtained by Sacher (1957, 1959).

It may well be that the inhibition of transpiration by auxins, as the cited authors report, is due to inhibition of water motion from the mesophyll cells into the intercellular spaces of leaves.

No changes resulted when TIBA and GA were applied.

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STRESZCZENIE

Zbadano wpływ kwasu 3-indolilooctowego, kwasu 2,3,5-trójjodobenzoesowego i kwasu giberelinowego na przepuszczalność błon komórek liści pomidorów metodą konduktometryczną opisaną przez Maximowa i Wasiljewą (1949) i stosowaną później przez Wasiljewą (1953).

Stwierdzono, że kwas 3-indolilooctowy obniża przepuszczalność błon komórek liści pomidorów, a kwas 2,3,5-trójjodobenzoesowy i kwas giberelinowy nie wywołują zmian w przepuszczalności.

Powyższe wyniki pozwalają przypuszczać, że obserwowane niejednokrotnie hamowanie transpiracji wywołane działaniem kwasu 3-indolilooctowego spowodowane jest zmniejszaniem intensywności przenikania wody z komórek miękiszu liści do przestrzeni międzykomórkowych.

Otrzymane rezultaty zgodne są z danymi uzyskanymi przez Sachera (1957, 1959). Mogą one wyjaśniać, stwierdzone przez niektórych autorów (np. Michniewicz, 1961), zjawisko obniżania się intensywności i transpiracji w wyniku działania kwasu 3-indolilooctowego, bez wpływu tego związku na stan otwarcia szparek.

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