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Marrè E, Lado P, Rasi-Caldogno F & Colombo R. Correlation between cell enlargement in pea internode segments and decrease in the pH of the medium of incubation. I. Effects of fusicoccin, natural and synthetic auxins and mannitol. *Plant Sci. Lett.* 1:179-84, 1973.
[Department of Biology, University of Milan, Italy]

This paper demonstrated that growth stimulation by auxins or by the toxin fusicoccin is associated with—and at least in part mediated by—an increase in proton secretion. Fusicoccin was thus shown to be an important tool for the study of hormone action and of proton transport at the plasmalemma. [The *SCI*® indicates that this paper has been cited in over 130 publications.]

Erasmo Marrè
Department of Biology
University of Milan
20133 Milan
Italy

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This paper reports the first results of a far-reaching line of work in which a group of plant physiologists working at the University of Milan are still fully engaged. A brief reconstruction of how this line of work developed might be of interest. For several years the activities of our group had been centered on the regulation of cell activities, including the interrelationships between growth and metabolism. In 1972 we were considering engaging ourselves in the development of some promising research on the regulation of cell division in yeast. At the same time, some results obtained in collaboration with the Alessandro Ballio group in Rome demonstrated the dramatic growth-promoting activity of the fungal toxin fusicoccin,[1,2] and this suggested that it might be used as a tool for the investigation of hormone-induced growth in plants.[3] We decided to concentrate on this topic and started our work by testing with fusicoccin the hypothesis that extension growth depends on the acidification of the wall space (as proposed at that time by other plant physiologists).[4] We were soon able to demonstrate that indeed the growth effect of fusicoccin was correlated with a marked stimulation of acid secretion and that this was also true for natural and synthetic auxins. In these investigations the fact that fusicoccin was much more active than auxin in promoting both growth and acid secretion was of fundamental help in defining the best experimental conditions for demonstrating the relatively weak effects of the natural growth hormone on these processes.

The development of these results immediately led us into the heart of a number of general problems. These problems included the enzymatic mechanism of active proton transport across the plasma membrane, its relationships with other transport processes, the regulation of the state of the apoplast, the role of electrogenic proton extrusion in the regulation of intracellular (and extracellular) pH, the relationships between pH changes, cell metabolism, and fundamental functions such as photosynthesis and the transition from dormancy to active growth.

In fact, most of these problems were successfully tackled in the following years, in our own as well as in several other laboratories,[5] showing that fusicoccin is indeed an important tool for the study of growth regulation, electrogenesis, and transport. The recognition of a receptor for this toxin in the plasma membrane was followed by the recent demonstration of the *in vitro* action of fusicoccin on the H^+-transporting ATPase of plasmalemma-enriched vesicles.[6] A role of the fusicoccin-activated H^+ pump in the regulation of intracellular pH, and thus of metabolism, was demonstrated. Considerable progress has also been made in the elucidation of the relationships between H^+ transport, electron transport by a plasma membrane redox system, photosynthesis, and germination.[4,5]

The relatively high number of citations to this paper may be explained by the number and importance of the general problems to which it opened a new experimental approach.

1. **Ballio A, Brufoni M, Casinovi C G, Cerrini S, Fedeli N, Pellicciari R, Santurbano B & Vaciago A.** The structure of fusicoccin A. *Experientia* 24:631-5, 1968. (Cited 110 times.)
2. **Lado P, Rasi-Caldogno F, Pennacchioni A & Marrè E.** Mechanism of the growth-promoting action of fusicoccin. Interaction with auxin and effects of inhibitors of respiration and of protein synthesis. *Planta* 110:311-20, 1973.
3. **Marrè E, Lado P, Rasi-Caldogno F & Colombo R.** Fusicoccin as a tool for the analysis of auxin action. *Atti Accad. Naz. Lincei Rend. Cl. Sci. Fis. Mat. Nat.* 50:45-9, 1971. (Cited 5 times.)
4. **Rayle D L & Cleland R.** Control of plant cell enlargement by hydrogen ions. *Curr. Top. Develop. Biol.* 11:187-211, 1977. (Cited 105 times.)
5. **Marrè E.** Fusicoccin- and hormone-induced changes of H^+ extrusion: physiological implications. (St. John J B, Berlin E & Jackson P C, eds.) *Frontiers of membrane research in agriculture.* Totowa, NJ: Rowman & Allanheld, 1985. p. 439-60.
6. **Rasi-Caldogno F, De Michelis M I, Pugliarello M C & Marrè E.** H^+-pumping driven by the plasma membrane ATPase in membrane vesicles from radish: stimulation by fusicoccin. *Plant Physiol.* 82:121-5, 1986.