

Marrè E. Fusicoccin: a tool in plant physiology.  
*Annu. Rev. Plant Physiol.* 30:273-88, 1979.  
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Fusicoccin stimulates electrogenic H<sup>+</sup> extrusion and K<sup>+</sup> uptake in plant cells. The important effects of this phytotoxin on solute transport, growth, transpiration, seed germination, and metabolism are interpreted as secondary consequences of the primary stimulation of the ATP-driven plasmalemma H<sup>+</sup> pump. [The SC<sup>2</sup>® indicates that this paper has been cited in over 285 publications.]

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January 8, 1987

Our group became involved in the problem of fusicoccin (FC) action as a consequence of some results obtained by Alessandro Ballio that showed that FC could at the same time both induce wilting and increase fresh weight in detached leaves. We concluded that FC induced cell-wall "loosening," and thus loss of turgor and cell enlargement, by the same mechanism proposed for auxin-induced growth stimulation. This suggested that FC might be a useful tool in the study of hormone-induced growth.

Further work rapidly broadened the field in which FC was shown to be a valuable tool. FC was found to stimulate electrogenic H<sup>+</sup> extrusion and K<sup>+</sup> uptake similarly to, but much more strongly than, auxin. Our main interest was, therefore, directed to the mechanism of proton transport and associated phenomena. In 1979 we proposed a scheme ac-

ording to which FC would primarily stimulate the ATP-driven H<sup>+</sup> pump of the plasma membrane, whereas its effects on solute transport, cell enlargement, transpiration, and seed germination would all be consequences of this primary activation of the proton pump.

This scheme fit in beautifully with the view, rapidly developing in animal biology, of an important role of intracellular pH in controlling various fundamental processes. We proposed that the regulation of the H<sup>+</sup> pump by specific natural effectors might play a role in various (as yet unidentified) physiological activities in plants as well.

Recent research confirmed and extended the hypothesis proposed in the 1979 paper. The direct action of FC on the plasma membrane proton pump was confirmed by finding that FC stimulates electrogenic H<sup>+</sup> extrusion in plasma membrane vesicle preparations,<sup>1</sup> and by demonstrating that the stimulation of the H<sup>+</sup> pump by FC and K<sup>+</sup> does indeed lead to cytosol alkalization.<sup>2</sup>

Evidence was obtained showing that the FC-sensitive H<sup>+</sup> pump is regulated by intracellular pH, transmembrane potential, and by some natural hormones other than auxin.<sup>3</sup> Some new, potentially important metabolic responses, such as abscisic acid-induced proline accumulation and the phosphorylation of a specific protein, were shown to be influenced both by FC and by treatments modifying cytoplasmic pH.<sup>2</sup>

The high number of citations to this paper presumably depends not only on its intrinsic interest, but also on our liberality in supplying FC to many colleagues (following the example given by Ballio, who first purified the toxin and elucidated its structure). Thus, citing our papers was a simple and much appreciated way to express one's thanks!

1. Rasi-Caldogno F, De Michelis M I, Pugliarello M C & Marrè E. H<sup>+</sup>-pumping driven by the plasma membrane ATPase in membrane vesicles from radish: stimulation by fusicoccin. *Plant Physiol.* 82:121-5, 1986.
2. Marrè M T, Romani G, Bellando M & Marrè E. Stimulation of weak acid uptake and increase in cell sap pH as an evidence for FC- and K<sup>+</sup>-induced cytosol alkalization. *Plant Physiol.* 82:316-23, 1986.
3. Marrè E. Fusicoccin- and hormone-induced changes of H<sup>+</sup> 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.