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This Week's Citation Classic®

Jones R J & Mansfield T A. Suppression of stomatal opening in leaves treated with abscisic acid. *J. Exp. Bot.* **21**:714-19, 1970.
[Department of Biological Sciences, University of Lancaster, England]

The newly discovered plant hormone, abscisic acid, was found to control the movements of stomata. A single, small dose applied to the leaf surface (0.02 $\mu g\ cm^{-2}$) could inhibit opening of the stomata for up to nine days. [The *SCI*® indicates that this paper has been cited in over 130 publications since 1970.]

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By 1969 we knew that the movements of stomata are profoundly affected if a plant is allowed to wilt for a short time. Although the leaves regain their normal appearance after rewatering, the stomata fail to open fully for many days. In that year S.T.C. Wright showed that the content of "inhibitor-β" (synonymous with abscisic acid [ABA]) was much greater in leaves after a period of wilting.[1] When we saw his paper, we realised that ABA might be responsible for altering the behaviour of stomata. However, it was not easy to obtain a sample of ABA to test our hypothesis, and we shall always be grateful to Trevor Chapman of Shell Research, Sittingbourne, England, for providing a small quantity of the pure compound, enough for the preliminary experiments.

These first experiments were carried out over the summer of 1969, when one of us (RJ) was in the first year of her PhD studies. They confirmed that our hypothesis was correct. ABA apparently caused stomatal closure by affecting the stomatal apparatus directly. The first results were reported in this paper, and soon after we also showed that ABA reduces the ability of guard cells to accumulate and/or retain potassium ions.[2] More recently, Enid MacRobbie at Cambridge has shown that ABA causes a transient efflux of both potassium and chloride ions.[3]

Although many phenomena in plants are thought to be under hormonal control, mimicking of these phenomena by a simple application of an exogenous compound is rare. This is probably why this paper has been cited so frequently. However, it is doubtful whether the aftereffects of wilting can be explained entirely in terms of endogenous changes in the ABA content of the leaf. Stomata are sensory devices that respond in a very complex way to changes in a plant's environment.[4]

More recent studies in Lancaster[5,6] have shown that stomatal guard cells react to ABA in a manner similar to the response to stimuli found in excitable cells in animals. ABA appears to increase the permeability of the plasma membrane to calcium ions, which then act as secondary messengers interacting with the protein calmodulin. Drugs that are employed by animal physiologists to control calcium fluxes, including some now used clinically, have been found to alter the responses of stomata to ABA.

As we learn more about the cellular mode of action of compounds like ABA, new possibilities for controlling physiological functions in plants begin to emerge. New generations of agricultural chemicals may be one of the benefits of research of this kind.

1. **Wright S T C.** An increase in the 'inhibitor-β' content of detached wheat leaves following a period of wilting. *Planta* **86**:10-20, 1969. (Cited 115 times.)
2. **Mansfield T A & Jones R J.** Effects of abscisic acid on potassium uptake and starch content of stomatal guard cells. *Planta* **101**:147-58, 1971. (Cited 100 times.)
3. **MacRobbie E A C.** Effects of ABA in 'isolated' guard cells of *Commelina communis* L. *J. Exp. Bot.* **32**:563-72, 1981.
4. **Mansfield T A & Davies W J.** Mechanisms for leaf control of gas exchange. *BioScience* **35**:158-64, 1985.
5. **De Silva D L R, Hetherington A M & Mansfield T A.** Synergism between calcium ions and abscisic acid in preventing stomatal opening. *New Phytol.* **100**:473-82, 1985.
6. **De Silva D L R, Cox R C, Hetherington A M & Mansfield T A.** Suggested involvement of calcium and calmodulin in the responses of stomata to abscisic acid. *New Phytol.* **101**:555-63, 1985.

