THE PHYSIOLOGY OF A WILTY MUTANT OF PISUM SATIVUM UNDER SIMULATED WATER STRESS CONDITIONS

Donkin, M. E., T. Hull, and E. S. Martin
Rumleigh Experimental Station, Plymouth, U. K.
Wang, T. John Innea Institute, Norwich, U. K.

Modifications of plant funotion caused by a single gene mutation can reveal insights into fundamental aspects of the physiology of plants, particularly in relation to their environment. Nowhere is this more apparent than in the water relations of crops. Mutations causing wilting, for example, have been reported in tomato, potato, corn and peppers. The cause of the abnormality has been ascribed to alterations in hormone balance, blocked vessel elements and changes in the ionic balance in the guard cells of the plants.

In 1976 Marx (2) described a wilty mutant of pea which wilted under conditions of water stress. We have recently carried out studies on the water relations and stomatal behavior of this mutant (called "Wilty" or JI 1069) to compare them with other non-wilty lines (JI's 1180, 1194 and 74) of similar phenotype (1). "Wilty" leaves had a lower percentage water content, a lower water potential and a lower diffusive resistance. In addition the guard cells of "Wilty" were slighty larger than those of several other non-wilty lines.

When stomatal behavior of "Wilty" was investigated it was found that the aperture of stomata on epidermal samples taken from plants in the light and dark period of a diurnal rhythm were larger for the "Wilty" compared to a non-wilty line (JI 1180). However, stomatal ones on detached epidermis to light, CO_2- and KCl concentration (in the medium) were similar in "Wilty" and non-wilty lines. There was also no difference in the response of stomata to the hormone, abscisic acid (ABA).

Preliminary studies of water loss from detached leaflets (to simulate water stress) showed (Fig. 1) that the "Wilty" line tends to lose water at a rate similar to that of a non-wilty pea during the first phase (I) of water loss, which is mainly due to stomatal and cuticular transpiration. However, after 60 min the water loss of the non-wilty pea begins to slow down as it enters the transition phase of the response curve (Phase II, Fig. 1). This response does not occur in the "Wilty" since water loss continues at the same rate for up to 90 min after excision. This indicates that the stomata fail to close as quickly in "Wilty" when it is under water stress. At the end of the experiment atrip* of upper epidermis were removed from each leaflet of the "Wilty" and non-wilty samples and stomatal apertures were measured under the microscope; Table 1 shows that the stomata of "Wilty" leaflets were slightly more open than those of the non-wilty plant.

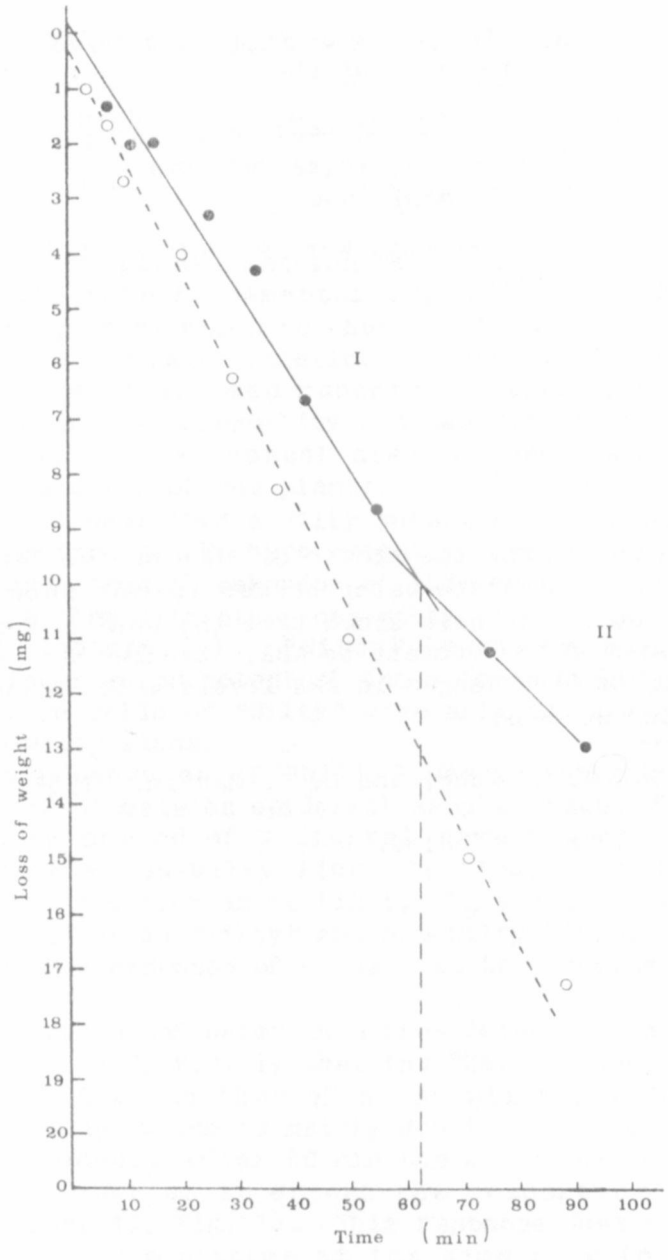
Table 1. Apertures of stomata on upper surface of "Wilty" and JI 1180 leaflets at the end of drying experiment.

Type	Aperture µm	Standard error
JI 1180	3.4	0.1
"Wilty"	4.6	0.1

The apertures of 30 stomata were measured for each type (10 on each epidermal strip).

As yet the reason for the slower closure of the "Wilty" stomata under conditions which simulate water stress is not known. Our studies using detached epidermis have shown that the answer does not lie in the intrinsic response of the stomata to ABA. Studies are currently under way to investigate the changes in ABA levels which occur in the "Wilty" plant after water stress.

1. Donkin, M. E., T. L. Wang, and E. S. Martin. 1983 - J. ex. Bot. (in press).
2. Marx, G. A. 1976. PNL 8:40.



Fig, 1, Water loss of detached leaflets of "Wilty" and a non-wilty (JI 1180) pea with time.
Leaflets were detached and placed upper surface uppermost in a controlled environment room under lights. The points shown are the average of 3 leaflets for each type. The rate of water loss for JI 1180 (mean area 330 mm^2) in Phase I was 4.70 x 10^{-4} mg/min/mm^2 and for "Wilty" (mean area 389 mm^2) was 5.23 x 10^{-4} mg/min/mm^2. In Phase II the rate measured from 75-90 min was 3.03 x 10-4 mg/min/mm^2 for JI 1180 and 5.14 x 10-4 mg/min/mm2 for "Wilty".

O——o "Wilty"

•——• non-wilty, JI 1180

The dashed vertical line indicates the point at which the stomata begin to close.