Field gas exchange as a component of agronomic research

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Agronomic experiments are always concerned with plant production and often with water balance. Growth and evapotranspiration of crops, as measured by frequent harvesting and water balance, are a consequence of the continuous, simultaneous processes of CO_2 (photosynthesis, respiration) and H2O (transpiration, soil evaporation) exchange with the aerial environment. These exchange processes respond to the short-term diurnal transients that characterize the field environment and also to daily changes in crop status that result from growth and water-use under the developing effects of the treatments under study. The processes of CO2 and H2O exchange are closely but not entirely linked and it is the nature of their response to environment and crop status that determines, within the framework of the underlying treatment, the potentially variable outcome in growth and the efficiency of water-use.

The measurement of gas exchange is thus a valuable companion activity in field agronomic research because it measures the effect of treatment at the level of the growth processes. More importantly, however, it allows analyses of the nature of crop response that are not possible by harvesting alone.

We illustrate this with examples taken from a range of agronomic experiments

1. With sunflower subjected to a range of irrigation strategies, daily photosynthesis and transpiration allowed an assessment of the adjustment of crop leaf area to the growth and water economy of the crop.

2. on soil treated with gypsum, daily gas-exchange measurements of lucerne defined treatment effects that determined growth response to extended interval of irrigation. Diurnal patterns of gas exchange were analysed to derive effects on efficiency of light utilization and stomatal conductance.

3. analyses of diurnal responses of sunflower, lucerne and ryegrass demonstrated the nature of the effect of treatment on crop activity and the consequent daily production, viz.
- role of wilting and leaf conductance in the response of sunflower and lucerne
- depression of photosynthesis of irrigated ryegrass but not of white clover appear to reflect response to high temperature