Field test for nitrate uptake by the crop

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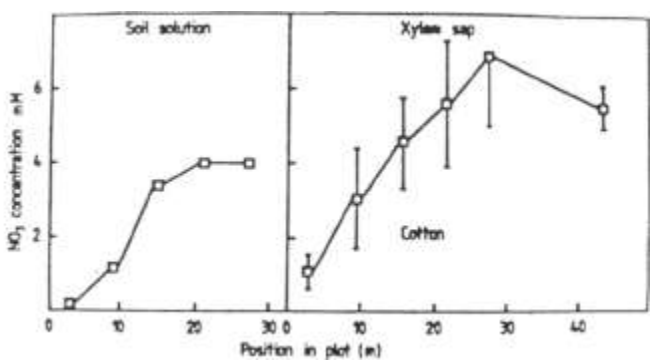
For many crops there is no adequate indicator of nitrogen nutritional status that allows farmers to decide on fertilizer application. Parameters such as leaf pigmentation or tissue N usually do not respond either quickly or greatly enough before nutrient stress occurs. Other more biochemical tests such as nitrate reductase activity are time consuming and require laboratory procedures. As nitrate is often the dominant form of N taken up by the crop a method has been developed to determine NO_{3-} supply to the above ground portion of the crop by measuring the concentration of NO_3 in the xylem.

Methods

A Schollander pressure vessel is used to firstly obtain the water status of a leaf and then extrude xylem sap. NO_3- is estimated semi-quantitatively with NO_3- specific test strips that change colour in proportion to NO_3- concentration. This differs from a test developed by Scaife and Stevens (l) that gives petiolar tissue values.

Results and Discussion

NO_3- levels in the xylem sap are well correlated with those in the soil (r^2 = d.90).



For wheat in the field there is considerable variation in the xylem NO concentration (cv. 46%) in apparently uniform plots. Part of this is due to horizontal heterogeneity in the soil NO_3- distribution (cv. > 20%) and in the glasshouse the cv. for xylem NO_3- is reduced to 24%. A large part of this is probably due to the inherent error (cv 20%) in the visual estimation of colour intensity. Recently an inexpensive hand held reflectance photometer has been used that lowers this uncertainty to 6%. Wheat plants extract NO_3- faster than water (ie active uptake) in a glasshouse hydroponics system where NO_3- concentration is held constant near the roots by a moving stream of nutrient solution. In contrast field grown plants exhibit xylem NO_3- levels lower than the bulk soil. This discrepancy between glasshouse and field is probably due to NO_3- being depleted locally within the root zone. Uptake rates are therefore due as much to movement of NO_3- through the soil as to the uptake properties of the root itself. The correlation between xylem and soil NO_3- can be improved by taking into account the distribution of the roots and NO_3- within the soil. When rate constants for uptake are obtained by dividing xylem by soil NO_3- concentration a varietal effect between wheat cultivars is evident for field but not for hydroponically' grown plants. This has been attributed to different rooting patterns. Measurement of xylem NO_3- by this method allows the two major constraints to crop growth (ie water and nitrogen) to be determined rapidly in the field and is the integrated result of both the root system and nutrient distribution within the soil.

1. Scaife, A. and Stevens, K. (1977) Grower 88: 1223-4.