

Physiology and molecular genetics of nitrogen management in maize and wheat: two models for the improvement of cereal productivity

Bertrand Hirel, INRA, France

Improvement of plant nitrogen (N) use efficiency (NUE: fertilizer taken up by the plants which is assimilated into organic N) could enable crop production under low N input, thus reducing ground water contamination by nitrates and possibly improving nutritional quality. To realize potential benefits with respect to sustained agriculture, we need to identify the physiological, biochemical and molecular mechanisms controlling inorganic N uptake, N partitioning between roots and shoots, as well as N reduction and its subsequent incorporation into organic molecules as a function of carbon skeletons availability. Moreover, an improved understanding of the transition between N assimilation and N remobilisation during plant ageing will be essential for improving crop N use efficiency, if we wish to reduce fertilizer input and improve or stabilize yield.

Therefore, improvement of NUE is an important goal, and consideration must be given both to the escalating cost of the fossil fuels required for producing N fertilizers and to N pollution of water supplies, caused by an excess of N application in agriculture. The latter is particularly relevant to maize and to a lesser extent to wheat. Therefore it is necessary to create new maize and wheat varieties which require less N fertilizer, while maintaining their output and the quality of the harvested product (content of proteins in particular). In addition to their agronomic value, maize and wheat were chosen as model plants since a wide panel of modern genetic tools is now available to better understand the biology of this species. They include a large number of Expressed Sequence Tags (ESTs) to perform transcriptome studies together with the possibility of developing quantitative approaches using genetic maps. The possibility of producing mutants and transgenic plants also constitutes a large advantage in developing multidisciplinary studies with these two crop species.

In this lecture, we describe how our understanding of the molecular controls of N assimilation in maize and wheat has been improved through the use of combined approaches including whole plant physiology, quantitative, forward and reverse genetics. Our current knowledge and prospects for future development and application to cereal improvement are explored.