Nitrogen Dynamics in Soil-Plant Systems

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Nitrogen plays a key role in plant nutrition. It is the mineral element required in the greatest quantity by cereal crop plants and it is the nutrient most often deficient. As a result of its critical role and low supply, the management of N resources is an extremely important aspect of crop production (Novoa & Loomis, 1981). Nitrogen is currently the most widely used fertilizer nutrient and the demand for it is likely to grow in the foreseeable future.

Despite this large investment in fertilizer N, the efficiency with which crops use it is poor. Allison (1965) suggested the average recovery of fertilizer N in the aboveground parts of crops is about 50%. Power (1981) has indicated that the general range of recovery in plant parts is between 20 to 90% of the fertilizer applied.

The N that is not recovered by the crop may be lost to the atmosphere through volatilization of ammonia, denitrification, or leaching, or made unavailable to the plant through immobilization in the soil. It may also become inaccessible to the plant through lack of water. The magnitude of each of the various transformations affecting the use of N is influenced by many climatic, edaphic, and agronomic factors. The myriad of transformation pathways and the multitude of factors affecting transformation rates renders N as one of the most complex plant nutrients to study. Quantifying these factors and predicting the response to added N is, thus, a very difficult task. The fraction of N that is lost from the cropping system is a source of some of the environmental pollution associated with fertilization. Thus, for economic and environmental reasons, a major thrust of current fertilizer research seeks to improve the efficiency of its use.

Traditionally, information used to generate a response curve is obtained from field experiments that test several increasing dressings of each nutrient to show how the fertilizer effects crop yields. This response information then forms the basis for deciding an optimum application rate. Regression models of fertilizer response, however, are static in nature and are unable to account for within-season variability in the supply of either water or nutrients.