

Limitations to efficient use of nitrogen for irrigated crops

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Loss of both fertiliser N and soil N is due mainly to a combination of NH_3 volatilization, leaching of NO_3^- and denitrification of NO_3^- . The relative importance of each of these processes is often difficult to determine, but it is clearly desirable from many points of view to minimise their effects. In many irrigated, fine-textured soils denitrification assumes a major role, leading to inefficient utilization of nitrogen fertiliser.

Laboratory incubations (with head-space analysis of denitrification products by gas chromatography) have demonstrated the high denitrification capacity of a range of irrigated, fine-textured soils. The effects of water potential, aeration status, nitrate status, respiration rate and recent cropping history on denitrification were examined. Although denitrification is regarded classically as an anaerobic process significant denitrification still occurred at low water potentials and high macropore oxygen tensions. Higher imposed NO_3^- levels were associated with greater rates of denitrification. Soils with high anaerobic respiration rates were more active denitrifiers. Rice cropping, in particular, resulted in depressed denitrification capacity.

These observations reinforce the view that large pre-plant applications of nitrogen fertiliser are likely to be very inefficient and that an irrigated crop should ideally receive nitrogen fertiliser inputs throughout its growth.

Accordingly, a field study was carried out to compare the recovery of fertiliser N from a single application prior to sowing, with various sources applied during the growth of an irrigated maize crop growing on a self-mulching grey soil. Anhydrous ammonia applied in the irrigation water increased grain yield by 24% when compared with the same amount of anhydrous ammonia injected below the hill before the crop was sown. We believe the increase in yield with the fertiliser applied in the water can be partly attributed to reduced losses of fertiliser N through denitrification.

A comparison of the sources of nitrogen applied in the irrigation water during the growth of the maize crop showed that there was a step wise decline in yield from urea to ammonium to nitrate as sources of nitrogen. The relative inefficiency of nitrate sources of fertiliser N was associated with rapid leaching out of the root zone to the top of the hill and to possible denitrification losses.

These results suggest a practical means of enhancing the efficiency of nitrogen fertiliser use during irrigated cropping viz. the application of urea in the irrigation water during the growth of the crop. At least two of the processes responsible for nitrogen loss from soil are thereby avoided.