Alternative nitrogen fertilization strategies for rice soils

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Worldwide studies using ^{15}N-labelled fertilizers have found that recoveries in rice plants rarely exceed 50% of the amount applied, and are commonly much less. Incorporation of the fertilizer into the soil has generally improved crop recovery. but deep placement has been even more effective. There have also been numerous reports of significantly increased yields associated with the use of slow release fertilizers and nitrification inhibitors.

Methods

Field trials comparing broadcast urea with deep placement of urea and 5 alternative N fertilizers were conducted on 2 soils (a transitional red-brown earth (RBE) and a self-mulching grey clay (GC)). The deep-placed fertilizers, including urea supergranules (lg), were applied by a fertilizer rig at a depth of 5-7cm. band spacing 30 cm. across the plant rows. Soil mineral N studies were conducted on the control and broadcast urea plots for several weeks after fertilization. N-labelled fertilizers were applied to microplots which were harvested either 2 weeks after fertilization or at physiological maturity.

Results and Discussion

On both soils the plants acquired significantly more fertilizer N when it was deep-placed compared with broadcast. Significantly more fertilizer N was retained in the soil and roots when the fertilizer was broadcast. largely due to greater immobilization in the top 5 cm. About /4 of the fertilizer was not recovered in the plants and soil.

The major loss mechanism is believed to be nitrification at the soil/water interface followed by denitrification. In the top 10 cm of the broadcast urea treatments, levels of mineral N in excess of the control were approximately 50% higher in the GC than in the RBE for at least 4 weeks after fertilization. Thus it might be expected that losses would be higher on the GC. Generally this was not the case. A number of factors are involved including the development of oxidized zones and rates of NH_4 diffusion and nitrification in the waterlogged soils. The advantage of deep placement appears to have been in reduced immobilization rather than in reduced losses. Plant response to deep placement was generally greater and with less immobilization on the GC than on the RBE. This is consistent with the observation that more of the broadcast fertilizer on the GC was located near the surface where microbial activity is likely to be greater. Whether the actual loss could be reduced by even deeper placement is an interesting question.

On the RBE the increased fertilizer N uptake with deep placement was not reflected in yield, yield components or efficiency of grain production (kg grain/kg applied N). However, fertilizer efficiency on the GC was significantly higher for deep placement of urea treated with DCD (a nitrification inhibitor) and deep-placed IBDU (a slow release fertilizer) when compared with broadcast urea.

Although the efficiency of the traditional method of broadcasting urea before permanent water was relatively good by world standards, substantial losses (1/4 to 1/3 rd) were still incurred. The fertilizer was applied at almost 1/2 the recommended rate, and losses would probably increase with rate of fertilization. The results showed that alternative fertilization strategies are likely to be more beneficial on the grey than on the red soil. On the grey soil deep placement of urea supergranules, urea with DCD and IBDD all showed promise.