Predicted consequences of early application of nitrogen fertiliser

J.E. Turpin[1], M.E. Probert[2] and M.A. Foale[2]

[1]NSW Ag, Toowoomba, Qld, 4350. [2]CSIRO Tag, St Lucia, Qld, 4067.

Abstract

The APSIM systems model was used to run simulated experiments at Dalby and Moree in the NE cropping zone, on the consequences of time of fertiliser application. This work attempted to reproduce the effects found in previous field work, and extrapolate the results over a greater range of seasons. These effects were successfully reproduced along with believable estimates of denitrification and leaching losses. Results suggest on average only small penalties for application of fertiliser during early and mid fallow.

Key words: wheat, denitrification, leaching

Introduction

Timing of fertiliser application can affect both the amount and distribution of available nitrogen (N) at planting. Strong and Cooper (2) found that fertiliser placement in the subsoil could improve N uptake and grain yield when a period of drought made topsoil N unavailable. They concluded that early application of fertiliser that is leached into the subsoil may improve N uptake in winter cereals. Further studies (3, 4) on both the timing and depth of application indicated that while deeper placement of fertiliser resulted in higher nitrogen recovery, this result was not obtained by early application of fertiliser, due to increased denitrification and leaching.

Growers are showing increased interest in the value of deeper nitrogen reserves, as illustrated by a ten-fold increase between 1992 and 1996 in the numbers of analyses on deep samples conducted at the Incitech laboratories in Brisbane (R. Strachan, pers. comm). Current practice regarding timing of fertiliser application for winter crops is highly variable. Some growers apply fertiliser at time of planting whilst others apply fertiliser in February-March. This simulation study investigated the effect of timing of fertiliser application over a much greater range of seasons than possible experimentally, in order to examine if there are any substantial gains or losses associated with different strategies, and when and how often they occur.

Methods

Simulation experiments were conducted using the APSIM systems simulator (1) configured for a wheat-fallow cropping sequence on a black earth at Dalby and a red clay at Moree. The simulator was run for 24 years at each site (1970 to 1993) with four rates of fertiliser (0, 50, 100 or 150 kg/ha of N) and three times of application: following harvest; in mid February; or at planting. The runs generated predictions of nitrate at planting, grain yield and N%, N-uptake, denitrification and leaching for each of the 12 scenarios. Soil N was set at 5 kg/ha at the beginning of each fallow.

Results and Discussion

During a wet fallow (results not shown) N from both the early and mid-fallow applications had moved as far as 120 cm, near the limit of the root zone for wheat. During dry fallows, early applied N moved no further than 60 cm. Earlier applications at both Dalby and Moree resulted in movement of fertiliser down the profile but not beyond the root zone, slightly more rapid leaching occurred in the lighter textured soil at Moree.

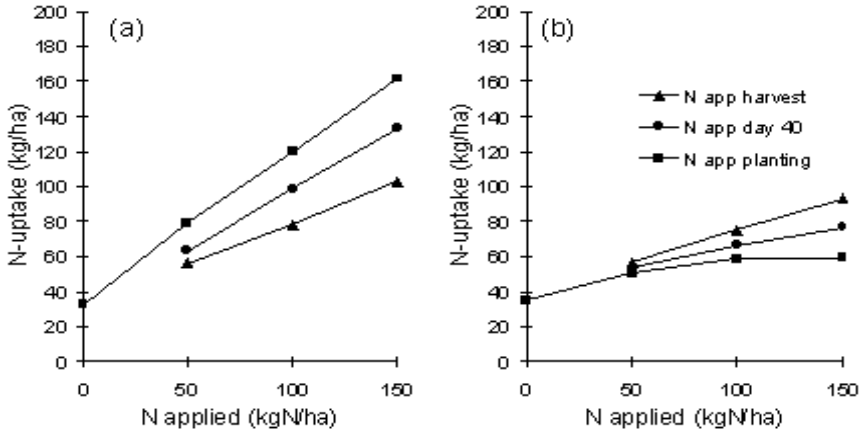

Figure 1. Crop nitrogen uptake in years with (a) a -ve response to early application and (b) a +ve response to early application.

Leaching and denitrification losses (results not shown) increased with earlier fertiliser applications and the rate of fertiliser application. However, leaching loss from the root zone was small because the model was re-initialised at harvest, thereby removing any residual N from the profile. In contrast, predictions of denitrification loss were significant when 150 kg/ha of N was applied after harvest, with the average loss from Dalby and Moree between 20 and 30 kg/ha. In the case of a February application of 100 kg/ha of N denitrification loss averaged 5 to 10 kg/ha. Losses were slightly higher at Dalby than Moree.

The pattern of N uptake by wheat varied with fallow and seasonal conditions. Following early application and a wet fallow when denitrification loss was high, N recovery in wheat was reduced (Fig. 1a). In some seasons, there was a positive response to early application because dry soil prevented uptake of N from topsoil while deeper N was recoverable (Fig. 1b).

At Dalby, a positive response to early and mid fallow applications occurred in 30% of seasons, 30% were unresponsive to application time, and 40% gave a negative response. At Moree, 12% of seasons produced a positive response to early and mid fallow applications, 21% no response, and 67% a negative response. The annual means for the two sites (data not shown) show that Moree, on average, has a small negative responsive to early application and Dalby with no response to time of application. This may be due to a higher frequency of in-crop rainfall at Moree and less seasons where dry topsoil rendered N unavailable and/or Moree's lighter textured soil allowed more rapid movement of nitrate from the topsoil.

Conclusions

On average, earlier fertiliser application (*eg*. February-March) results in reduced N available to the wheat crop, primarily because of denitrification loss. However, positive benefits from early application can occur (approximately 30% of seasons at Dalby).

References

1. McCown, R.L., Hammer, G.L., Hargreaves, J.N.G., Holzworth, D.P. and Freebairn, D.M. 1996. *Agricultural Systems*. **50**, 255-271.

2. Strong, W.M. and Cooper, J.E. 1980. *Aust. J. Exp. Agric. Anim. Husb*. **20**, 82-87.

3. Strong, W.M. and Cooper, J.E. 1992*. Aust. J. Soil. Res*. **30**, 695-709.

4. Strong, W.M. Saffigna, P.G.,Cooper, J.E. and Cogle, A.L. 1992. *Aust. J. Soil. Res*. **30**, 711-721.