SHREE DEV BHOOMI INSTITUTE OF EDUCATION SCIENCE AND TECHNOLOGY

DEPARTMENT OF AGRICULTURE

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SUBJECT- FARMING SYSTEM

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Topic- Strategic use of mineral fertilizer

Recovery of fertilizer nitrogen (N) applied to winter wheat crops at tillering in spring is lower than that of N applied at later growth stages because of higher losses and immobilization of N. Two strategies to reduce early N losses and N immobilization and to increase N availability for winter wheat, which should result in an improved N use efficiency (= higher N uptake and/or increased yield per unit fertilizer N), were evaluated. First, 16 winter wheat trials (eight sites in each of 1996 and 1997) were conducted to investigate the effects of reduced and increased N application rates at tillering and stem elongation, respectively, on yield and N uptake of grain. In treatment 90-70-60 (90 kg N ha^{-1} at tillering, 70 kg N ha^{-1} at stem elongation and 60 kg N ha^{-1} at ear emergence), the average values for grain yield and grain N removal were up to 3.1 and 5.0 % higher than in treatment 120-40-60, reflecting conventional fertilizer practice. Higher grain N removal for the treatment with reduced N rates at tillering, 90-70-60, was attributed to lower N immobilization (and N losses), which increased fertilizer N availability. Secondly, as microorganisms prefer NH_4^+ to NO_3^- for N immobilization, higher net N immobilization would be expected after application of the ammonium-N form. In a pot experiment, net N immobilization was higher and dry matter yields and crop N contents at harvest were lower with ammonium (ammonium sulphate + nitrification inhibitor Dicyandiamide) than with nitrate (calcium nitrate) nutrition. Five field trials were then conducted to compare calcium nitrate (CN) and calcium ammonium nitrate (CAN) nutrition at tillering, followed by two CAN applications for both treatments. At harvest, crop N and grain yield were higher in the CN than in the CAN treatment at each N supply level. In conclusion, fertilizer N use efficiency in winter wheat can be improved if N availability to the crops is increased as a result of reduced N immobilization (and N losses) early in the growth period. N application systems could be modified towards strategies with lower N applications at tillering compensated by higher N dressing applications later. An additional advantage is expected to result from use of nitrate-N fertilizers at tillering.

T he loss of N from intensively-managed grasslands is much greater than imagined,and can be equal to, or greater than those from arable systems. This has serious financial and environmental implications. A typical intensive dairy farm, for instance, might import over 450 kg N per hectare per year (mostly as fertilizer (80%),purchased feed, and as natural N deposits from the atmosphere) but only about 17% of this may be recovered in meat or milk products. The rest is lost to the environment. Therefore, it is in the interests of farmers to improve fertilizer management (Figure8.1). This would be beneficial both for profit margins and in reduced environmental damage.

How is nitrogen lost?

One of the main routes of N loss, especially on coarse-textured soil, is nitrate leaching. This occurs mainly during the winter, when percolating rainfall carries nitrates down through the soil. Concern about the potentially harmful effect that nitrate can have on the environment and human health led to the formulation of European legislation for nitrate in drinking water. The EC limit is 11.3 mg N per litre, and is to be implemented in the UK by December1999. At IGER, North Wyke, we have developed a mathematical model of the N cycle in grassland systems ('NCYCLE') which predicts that peak nitrate concentrations in drainage water could greatly exceed the EC limit even when

Table 8.1 Examples of 'NCYCLE' predictions of peak nitrate concentration in drainage water from a grazed sward

Soil type	Sward characteristics	Annual fertilizer input kg N per ha (units per acre)	Peak nitrate concentration (mg N per litre)
Sandy loam, well drained	7-10 year old sward, with history of long-term grassland	340 (272)	43
Clay loam, poorly drained	2-3 year old sward, history of mixed ley and arable use	340 (272)	18
EC limit			11.3

recommended levels of fertilizer are applied (Table 8.1).

Improving the efficiency of N use

There are two main means by which fertilizer maybe managed to improve N use efficiency: The first is to take account of the mineral N(ammonium and nitrate) already in the soil. When mineral N accumulates in the soil, it is susceptible to the processes of loss. Mineral N in the soil at the end of the growing season is particularly at risk, since uptake of N by the sward is reduced, and heavy rainfall can cause nitrate leaching. Soil mineral N may have come from previous fertilizer dressings, from applied slurry or from mineralization of organic matter. The amount of N that the soil can supply through mineralization may be insufficient to produce a yield acceptable to most farmers, but nevertheless is a source of substantial quantities of N. Soil mineral N is taken into consideration to some extent in current fertilizer recommendations,by categorising the soil's N supplying potential.There is, however, opportunity for much improvement, by monitoring mineral N content during the growing season.

Integrated soil testing approach

Both of these means of improving efficiency of N use are incorporated in a new integrated soil testing and modelling approach, developed at North Wyke.Modelling allows the links between fertilizer use,production (crop yield) and N loss to be explicit. Therefore for a given system, crop yield and N loss can be predicted for a specified annual fertilizer total. The new IGER model, "NFERT", aids management by allowing the farmer to set targets,which may be production-or loss-based. Loss-based targets may be particularly useful in designated areas such as Nitrate Vulnerable Zones, in which farmland must be managed in a manner which protects water quality. Having established the total fertilizer required for a given target, NFERT defines the timing and amount of fertilizer to be applied. This enables targets to be achieved with the best possible N use efficiency. The model provides two pieces of information at any point in time; one which specifies the mineral N that is in the soil (i.e. that which could be measured) and the second which specifies the optimum soil mineral content to achieve the specified target. This information is shown in Figure8.4 along with the predicted optimum level of fertilizer application (each month). Soil testing through the growing season allows the mineral N content of the soil, relative to the model's prediction, to be checked. In this way, fertilizer dressings can be adjusted to take account of the mineral N in the soil in order to achieve maximum crop yield with minimal loss of N to the environment.

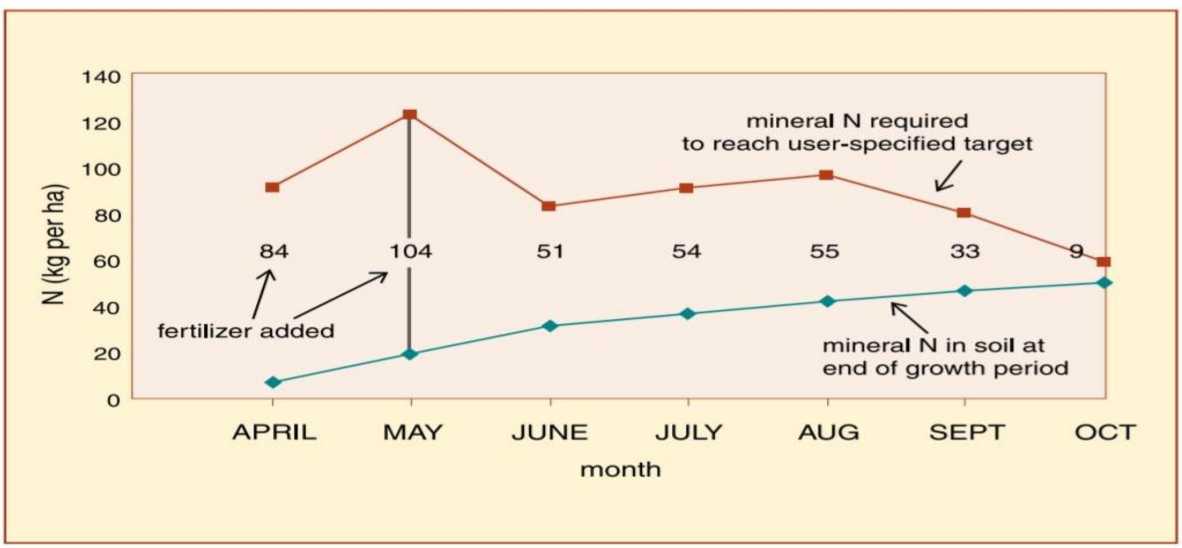

Figure 8.4 Example of the output from the NFERT model showing the soil mineral N profile and the soil N level required for a target of 10.3 t of dry matter production on a moderately-drained, sandy loam soil. The difference between the two is the amount of fertilizer which needs to be added each month.