EVOLUTION OF NITROGEN APPARENT RECOVERY INDEX OF TOTAL NITROGEN SOLID MANURE APPLIED EVERY YEAR ON A CUT PERENNIAL RYE GRASS

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ABSTRACT

One trial was carried out from 1996 to 2002 in Pays de la Loire Region (West of France) at La Jaillière Experimental Station (44). The objective of the experimental device was to appraise the evolution of the nitrogen apparent recovery (NAR) indexes of 4 solid manure : stored or composted cattle solid manure, stored or composted broiler litter. These solid manure have been applied every years in autumn on a cut perennial rye grass.

NAR indexes have been calculated for each annual rate of solid manure applied on perennial rye grass. Careful examination of the results shows that no significant increase of the NAR indexes has been observed over the seven years duration of the experiment whatever the type of applied solid manure.

INTRODUCTION

After spreading, an important fraction of nitrogen solid manure meets the nitrogen stack of soil organic matter. Regular applications of solid manure must, therefore, lead to a progressive increase of nitrogen apparent recovery (NAR) indexes of total nitrogen of these solid manure. Indeed, crops will gain nitrogen not only from the solid manure rate applied at the start of every rotation, but also by an extra mineralization of the nitrogen stack of the soil organic matter.

In the western part of France, very few experiments have been carried out on this topic until the outset of 1990's. This lack of references on the evolution of nitrogen efficiency of solid manure applied regularly on grassland has lead to set up several long term trials in the western part of France from the mid of 1990's.

In this paper, we present the results of a trial implemented by ARVALIS – Institut du Végétal in 1996.

MATERIAL AND METHODS

The trial has been set up at the experimental station of La Jaillière (44) in Pays de la Loire Region, western part of France, during the campaign 1995-1996.

Regional climate is classified in the temperate oceanic type with an average annual temperature of 12.1°C and an average annual rainfall of 715 mm.

The soil is a gleyic cambisoil lying on an alterite of sandstony schist. This one has been drained with plastic pipes in 1981. Its available water capacity is about 100 to 120 mm. Average annual drainage under grassland reaches 200 mm.

Arable layer texture characteristics are the following : gravels 20 – 30 %, sandy silty loam, Metson CEC 10.2 cmole/kg, total organic matter 2.44 %, C/N 9.6 and pH in water 6.6.

The experimental device has allowed for assessing nitrogen efficiency of 4 solid manure: cattle stored solid manure, cattle composted solid manure, stored broiler litter and composted

broiler litter. These manure are applied on perennial rye grass every year in autumn. Their nitrogen effects on the grass are compared each year with five mineral nitrogen rates (table 1).

Table 1. *Compared treatments*

Nitrogen fertiliser type	Nitrogen rate (in kg N/ha)
Cattle stored solid manure	200
Cattle composted solid manure	200
Stored broiler litter	200
Composted broiler litter	200
Ammonium nitrate 33.5	0
	X/4
	X/2
	3X/4
	X (1)

(1) X is the optimum nitrogen rate.

Statistical device is a factorial block design with treatments repeated three times.

Table 2 shows the average composition of the applied solid manure.

Table 2. *Average composition of the applied solid manure*

Type of manure	Dry matter (% FP) (1)	Total nitrogen (‰ FP)	Mineral nitrogen (‰ FP)	C/N
Cattle stored solid manure	35	9	0.4	14
Cattle composted solid manure	36	11	0.5	12
Stored broiler litter	68	26	3.9	11
Composted broiler litter	64	22	2	10

(1) FP = fresh product

Nitrogen efficiency of each solid manure has been appraised through the NAR index. This one has been calculated with the following equation :

$$NAR = \frac{Nabs_{org} - Nabs_{0}}{N_{tot\ org} + S_{org} - S_{0}} \quad \text{with}$$

$Nabs_{org}$ = annual nitrogen exportation by perennial rye grass cuts in an organic treatment,

$Nabs_{0}$ = annual nitrogen exportation by perennial rye grass cuts in the zero nitrogen treatment,

$N_{tot\ org}$ = total nitrogen content of the solid manure applied in autumn,

S_{org} = stack of soil mineral nitrogen from 0 to 90 cm in an organic treatment before application of solid manure in autumn,

S_0 = stack of soil mineral nitrogen from 0 to 90 cm in the zero nitrogen treatment before application of solid manure in autumn.

RESULTS AND DISCUSSION

The figure 1 shows the evolution of the NAR indexes of stored or composted cattle solid manure for the perennial rye grass from 1996 to 2002. In contrast with the NAR indexes of ammonium nitrate, the nitrogen apparent recovery indexes of the both solid manure have stayed very stable during these seven successive years with an average value of 0.10.

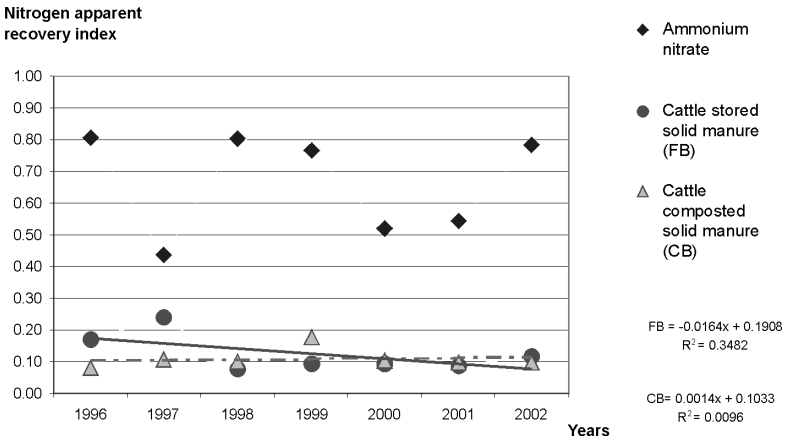

Figure 1. *Evolution of the nitrogen apparent recovery indexes of ammonium nitrate and cattle solid manure by perennial rye grass*

With the stored broiler litter (figure 2), the NAR indexes are firstly near of 0.30 from 1997 to 2000, then decrease to 0.20 during the years 2001 and 2002. Indeed stored broiler litter applied in autumn 2001 and in autumn 2002, were higher in mineral nitrogen than for the previous period. As well the nitrogen losses by volatilisation, denitrification and lixiviation after autumn manure spreading were probably very important during the autumns and winters 2000-2001 and 2001-2002.

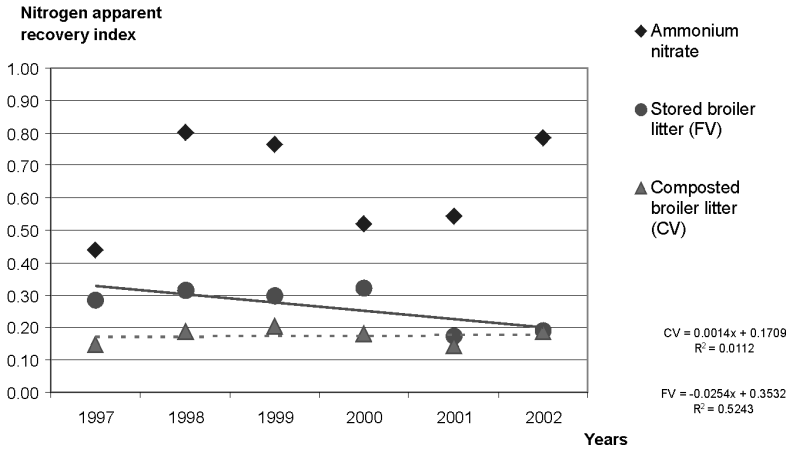

Figure 2. *Evolution of the nitrogen apparent recovery indexes of ammonium nitrate and broiler litter by perennial rye grass*

At last, the NAR index of the composted broiler litter stayed very constant from 1997 to 2002 with an average value of 0.17.

CONCLUSIONS

Scanning the evolution of NAR indexes of total nitrogen of the solid manure applied every year on a cut perennial rye grass does not indicate any significant increase from 1996 to 2002.

In this situation, (temperate oceanic climate, soil well provided with organic nitrogen, cut perennial rye grass and moderate rate of solid manure), a duration of 6 or 7 applying years is probably too short to observe significant nitrogen residual effects. As well, the NAR indexes calculated can be seen like the result of nitrogen direct effect of successive solid manure application.

REFERENCES

Bodet, J.M., Trochard, R., Corgnet, M. 2004. Les arrière-effets « azote » : Etude des effets à moyen terme d'apports répétés de fumiers de bovins ou de fumiers de volailles, bruts ou compostés, sur une rotation maïs-blé et une prairie installée. Compte rendu. 103 p.