EVOLUTION OF NITROGEN APPARENT RECOVERY INDEX OF TOTAL NITROGEN SOLID MANURE APPLIED EVERY TWO YEARS IN A MAIZE WHEAT ROTATION

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ABSTRACT

Two trials were carried out in Brittany (West of France) at Kerguehennec (56) from 1987 to 1998 and at Crécom (22) from 1987 to 2000. The objective of the both experimental devices was to appraise the evolution of the nitrogen apparent recovery (NAR) indexes of two solid manure types : cattle stored solid manure and stored broiler litter. These solid manure have been applied every two years on a maize rotating with a winter wheat.

NAR indexes calculated for the winter wheat have allowed of evaluating the evolution of nitrogen residual effects of solid manure applied regularly on maize over the duration of the two trials. Careful examination of the results does not show any significant increase of these nitrogen residual effects with the years.

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 1980's. This lack of references on the evolution of nitrogen efficiency of solid manure applied regularly on arable land has leaded to set up several long term trials in Brittany between 1985 and 1990.

In this paper, we present the result of two trials implemented in partnership by ARVALIS – Institut du Végétal (formerly ITCF) and Breton Agriculture Boards.

MATERIAL AND METHODS

Two long term trials have been set up at Kerguehennec (56) and Crécom (22) in Brittany, western part of France, during the campaign 1986-1987.

These both experiments have a temperate oceanic

***Figure 1**. Location of the two trials*

climate with an average annual temperature of 11.4°C at Kerguehennec (56) and 10.3°C at Crécom (22). The average annual rainfall is 802 mm at Kerguehennec (56) and 974 mm at Crécom (22).

The soil of Kerguehennec (56) is an eutric luvisoil lying on an alterite of micaschist. This one of Crécom (22) is a dystric cambisoil lying on a granite. Their water available capacity is respectively of 100-120 mm at Kerguehennec (56) and 70-90 mm at Crécom (22). The both sites are characterized by a good soil infiltration rate, especially at Crécom (22). After all, the average drainage between winter wheat harvest and maize sowing reaches 400 mm at Kerguehennec (56) and 600 mm at Crécom (22).

The arable layer texture is classified into the sandy silt loams at the both sites. Organic and acido-basic status of the upper layer is presented in the table 1.

***Table 1**. Organic and acido-basic status of the arable layer in the both experiments.*

Experiments	C total (% dry fine earth)	C/N	CEC (in cmol/kg of dry fine earth)	pH in water
Kerguehennec (56)	2.1	10	90	6.3
Crécom (22)	2.1	9.3	116	6.0

The experimental device has allowed to assess nitrogen efficiency of two solid manure : cattle stored solid manure and stored broiler litter, applied every two years before maize sowing in a maize-winter wheat rotation. The nitrogen effects of the both manure on maize (direct effect) or winter wheat (residual effect) can be compared each year with three mineral nitrogen rates (table 2).

***Table 2**. Compared treatments in the both experiments.*

Nitrogen fertiliser type	Nitrogen rate (in kg N/ha)	
	Maize	Winter wheat
Cattle stored solid manure	100-150	0
Stored broiler litter	100-200	0
Ammonium nitrate 33.5	0	0
	X – 40 or 60 (1)	X – 40 or X – 50 (1)
	X or 120 (1)	X (2)

(1) Crécom (22) (2) X is the optimum nitrogen rate

Each trial is set up according to a factorial block design with five treatments repeated three times at Crécom (22) and for times at Kerguehennec (56).

The table 3 shows the average composition of the applied cattle stored solid manure and the stored broiler litter used at Kerguehennec (56) and at Crécom (22).

***Table 3**. Average composition of the applied solid manure (1).*

Type of manure	Experimental sites	Dry matter (% FP)	Total nitrogen (‰ FP)	Mineral nitrogen (‰ FP)	C/N
Cattle stored solid manure	Kerguehennec (56)	21	5	0.9	18
	Crécom (22)	24	4	0.74	14
Stored broiler litter	Kerguehennec (56)	46	22	12	7
	Crécom (22)	68	25	5.1	9

(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 :

$$NAR = \frac{Nabs_{org} - Nabs_0}{N_{tot\ org} + S_{org} - S_0} \quad \text{with}$$

$Nabs_{org}$ = nitrogen absorption before harvesting of aerial parts of the maize or the winter wheat in a treatment receiving solid manure,

$Nabs_0$ = nitrogen absorption before harvesting of aerial parts of the maize or the winter wheat in a treatment without nitrogen fertilisation,

$N_{tot\ org}$ = total nitrogen content of the solid manure applied before maize sowing,

S_{org} = stack of soil mineral nitrogen from 0 to 90 cm in a treatment receiving solid manure before application of solid manure for the maize or on the end of the winter for the winter wheat,

S_0 = stack of soil mineral nitrogen from 0 to 90 cm in a treatment without nitrogen fertilisation before application of solid manure for the maize or on the end of the winter for the winter wheat.

RESULTS AND DISCUSSION

In this part, we have selected to solely present the values of the NAR indexes calculated for the winter wheat. Indeed, these values only reflects the residual nitrogen effects of the successive solid manure applications on maize and not the result of the addition of direct and residual nitrogen effects.

The data achieved at Kerguehennec (56) and at Crécom (22) have allowed to calculate NAR indexes during the following periods :

1988 to 1998 with 6 consecutives values at Kerguehennec (56),

1990 to 2000 with 4 consecutives values for the stored broiler litter and 5 consecutive values for the cattle stored solid manure at Crécom (22).

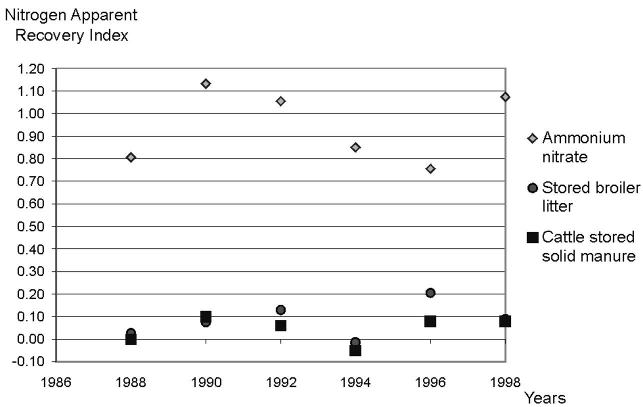

***Figure 2**. Evolution of the nitrogen apparent recovery indexes of the solid manure applied every two years on maize for the following winter wheat at Kerguehennec (56)*

The figure 2 shows that NAR indexes of the both solid manures have not significantly increased at Kerguehennec (56) between the first and the last winter wheat. Difference between the values achieved with two successive winter wheat crops, for instance 1994 and 1996, can be higher than the difference between the results of the first (1988) and the last (1998) campaign with winter wheat. As well, we cannot conclude that the nitrogen residual effects of solid manure applied every two years on maize have increased from 1988 to 1998 at Kerguehennec (56).

Careful examination of the results achieved at Crécom (22) even indicates that the NAR indexes by the winter wheat can hardly decrease after 4 consecutive applying of solid manure (figure 3).

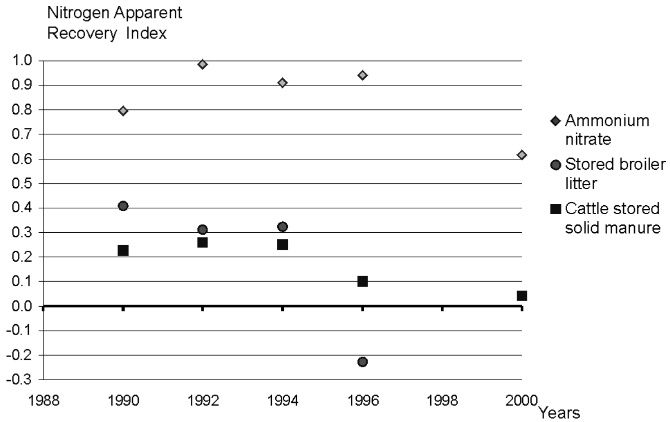

Figure 3. *Evolution of the nitrogen apparent recovery indexes of the solid manure applied every two years on maize for the following winter wheat at Crécom (22)*

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