ASSESSING N DYNAMICS OF ORGANIC WASTES IN FIELD CONDITIONS USING A CALCULATION MODEL

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INTRODUCTION

Recycling organic wastes by land spreading may increase the risk of nitrate leaching when N contained in wastes mineralises or when wastes contain inorganic N. To limit environmental impacts, it is necessary to get better knowledge on the behaviour of wastes after spreading onto soil (i.e. N mineralisation dynamics) in order to provide more accurate recommendations and guidelines for farmers. For this purpose, we characterised N release of sewage sludges (SS) and untreated waste waters (WW) from food-processing industries in field conditions.

MATERIALS AND METHODS

The field trial was set up during August 2000 for 18 months. Seven treatments (3 replicates) were considered: control soil without spreading and soil after spreading with six different wastes selected from a previous laboratory experiment study (effluents from alfalfa dehydrating industry or distillery or sugar refinery, municipal sludge or sludge from distillery). Each experimental plot was 16 m wide and 35 m long, and the wastes were applied with standard spreading equipment. Distribution and application rate of wastes were precisely measured using rectangular trays put on the soil surface along four transects to collect the wastes during spreading. Moreover, wastes were sampled during spreading for their characterisation. All plots were maintained bare fallow during the whole experiment using chemical herbicides. Soil cores were sampled every 2-3 weeks to 120 cm depth (divided in 4 equal layers), moisture and inorganic N (NH_4^+ and NO_3^-) contents being determined in soil for each layer. Meteorological data were collected automatically every day. The daily values of water evaporation and drainage, N mineralisation and leaching were calculated using the measured data and the LIXIM model (Mary et al., 1999). LIXIM is a capacity-type model applied to a layered soil; input data are: meteorological data (rainfall, PET, temperature), basic soil properties (bulk density, moisture at field capacity and wilting point), and moisture and inorganic N contents in each soil layer at each sampling date. N Mineralised and N leached due to waste application were calculated as the difference between amended and control soils.

RESULTS AND DISCUSSION

Analyses and field trial results confirmed the diversity of the wastes (Table 1). The C:N ratios varied from 5.3 to 21.2. LIXIM was able to reproduce satisfactorily the water and inorganic N contents measured in all treatments (e.g. Distillery sewage sludge Fig. 1). The wastes also induced very different N mineralisation rates and dynamics: wastes n° 2 and n° 5, (with a low C:N ratio), induced net N mineralisation just after spreading, whereas wastes n° 3 and n° 6 led to N immobilisation (for one month) and subsequent N release. N was immobilised for more than one year after spreading of WW n° 1 and n° 4 (sugar refinery WW was almost stable with little N immobilised, while alfalfa dehydrating WW had a high immobilisation rate). Nevertheless, in this last case, amounts of N immobilised were low since this effluent contained a low amount of organic N. N leached after application of wastes n° 1, 2, 5 and 6, (which represented from 24 to 39 % of waste total N), came from the mineralisation of organic N and inorganic N contained in the wastes. These results justify the growth of catch crops when these wastes are spread in summer or autumn. WW n° 4 did not contain inorganic N and did not release N, thus it induced less leaching than the control soil. Waste n° 3 caused no leaching during the first winter, but it did in the following year, due to net N mineralisation during this period (results not shown), which should be taken into account for fertilisation of the following crop.

Table 1. *Amounts of applied N, N mineralisation rates and N leaching following spreading (SS = sewage sludge, WW = waste water).*

	Organic N applied *kg N ha^{-1}*	NH_4^+-N applied *kg N ha^{-1}*	Organic C:N ratio	Waste N mineralised *% of added organic N*			N leached *% of added total N*		
Days after spreading				*29*	*85*	*374*	*29*	*85*	*374*
1. Alfalfa dehydrating WW	42	36	13.4	-74	-55	-49	0	0	+29
2. Liquid distillery SS	117	38	5.3	+4	+28	38	0	-6	+29
3. Distillery WW	141	2	15.5	-3	+8	+26	0	-3	+3
4. Sugar refinery WW	230	0	21.2	-4	-3	-2	0	+1	-6
5. Solid distillery SS	52	21	7.4	0	+60	+58	0	-13	+39
6. Municipal SS	113	20	14.6	-2	+15	+46	0	-2	+24

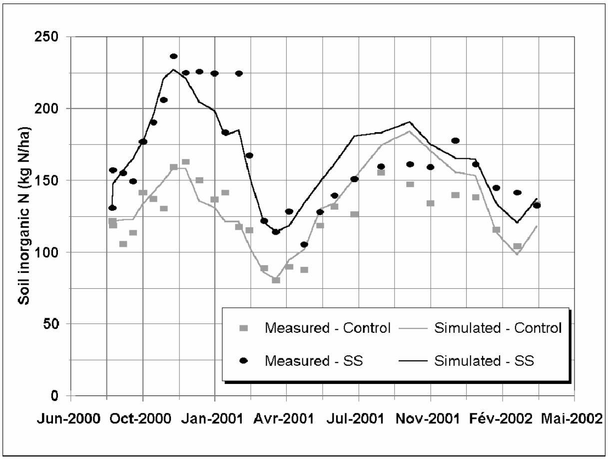

Figure 1. *Observed and simulated evolution of water (left) and inorganic N (right) in soil profile after spreading of distillery sewage sludge.*

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