Effect of Different Carbon and Nitrogen Inputs on Soil Chemical and Biochemical Properties in Maize-Based Forage Systems in Northern Italy

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Introduction In agroecosystems, manure application and straw return affect carbon (C) and nitrogen (N) cycling and affect soil organic matter (SOM), nutrient supply and losses to the environment. We examined effects of different organic sources on crop production, N uptake and surplus and SOM in maize systems.

Materials and methods The experiment (established 1992), is located near Turin, northern Italy, on a deep calcareous sandy-loam soil in a completely randomised block design with 3 replicates. Treatments were maize: either silage (MS), or grain (MG); receiving N as liquid (LM) or solid (SM) manure, and/or urea at a nominal total input of 300 kg/ha (Table 1). N supply/uptake and crop production were measured each year. In 2003, soil organic C and total N contents were assessed and in 2004, the potential N availability SOM from mineralisation was assessed by anaerobic incubation (Waring & Bremner, 1964) and hot KCl extraction (Whitehead, 1981).

Table 1 Crop and fertiliser application to the treatments

Treatment	Crop	Liquid manure	Solid manure	Urea
		N kg/ha		
MS0	Maize silage	0	0	0
MS300	Maize silage	0	0	305
MG300	Maize grain	0	0	305
MS300LM	Maize silage	222	0	100
MS300SM	Maize silage	0	285	100

Table 2 Crop/*grain production, N uptake and balance: different letters indicate differences at P<0.05 (SNK test)

Treatment	Crop prod. DM t/ha		Uptake	Offtake	Balance
			N kg/ha		
MS0	16.4[a]		128.2[a]		-128.2
MS300	24.3[b]		248.7[b]		56.3
MG300	25.8[b]	13.3*	273.9[b]	185.6	119.4
MS300LM	25.3[b]		253.8[b]		67.8
MS300SM	24.9[b]		254.1[b]		131.3

Results Application of animal manures or crop residues had no effect on dry matter production or N uptake (Table 2). However, N balance was higher with SM from the extra N supplied, and with MG, from the crop residues on the soil surface. Treatments produced differences in SOM (Table 3). In particular, the larger C and N supply (from manure or maize straw returned to the soil) increased soil C and N contents. The two potential N mineralisation methods showed different results. Whilst amounts of N released during anaerobic incubation were clearly related to SOM accumulation, i.e. more mineralised N with higher soil C and N contents, N mineralisation through hot KCl extraction seemed to be more dependent on amounts of organic residues added: the higher values with higher rates of straw return in MG 300, or to higher rates of manure in MS300SM.

Table 3 Soil C, N and C/N ratio and potentially mineralisable N in the 0-30 cm layer: different letters indicate significant differences at P<0.05 (SNK test)

Treatment	C org	N tot	C/N	Anaerobic incubation	Hot KCl
	%	%		NO_3-N mg/kg	
MS0	0.95[a]	0.11[a]	8.57[a]	30.7	12.2
MS300	0.96[a]	0.12[a]	8.26[a]	23.6	18.2
MG300	1.12[ab]	0.13[a]	8.64[a]	42.5	23.5
MS300LM	1.15[b]	0.13[b]	8.64[a]	54.8	18.3
MS300SM	1.36[c]	0.15[c]	8.89[a]	66.7	21.0

Conclusions Treatments did not affect crop production or uptake, but caused differences in SOM. Manure application, and the return of straw increased soil C and N. Potential N mineralisation was related to soil C and N contents, but showed different ranking depending on the quality of accumulated SOM.

References

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