Influence of solid vs. liquid digestate application on soil organic matter accrual and stabilization, and microbial communities evolution

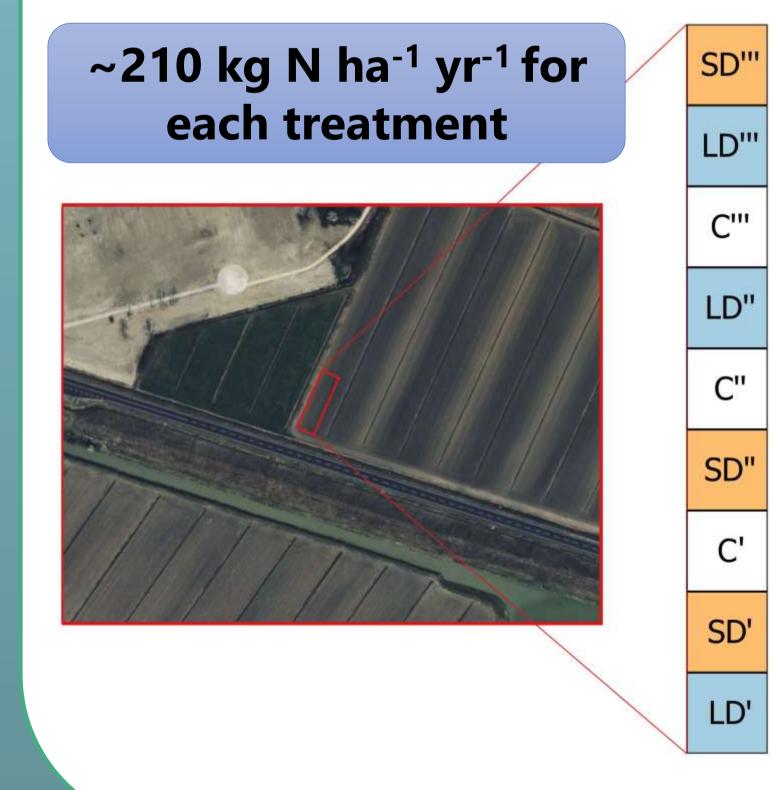
1. Introduction

The decline of soil organic matter (SOM), as well as the depletion of micro and macronutrients, are among the most serious threats facing many agricultural soils in the world. In many Countries, soil amendments are increasingly originating from a wide range of organic wastes, as a win-win strategy to mitigate global warming while increasing soil fertility and food security. Digestate, a by-product of the anaerobic digestion, is often used as a fertilizer and/or an organic amendment. However, a safe and sustainable application of digestate in agriculture requires an indepth understanding of its possible impacts on native SOM, on carbon (C) sequestration mechanisms, as well as on soil microbial communities.

2. Objective

To test the influence of solid *vs*. liquid digestates on both SOM accrual and the distribution of SOM in particulate organic matter (POM) and mineral associated organic matter (MAOM) pools. Moreover, the abundance of key genes related to the N cycle was assessed.

3. Experimental design



Depths (cm): 0-15

15-30

- Time:
- $\mathbf{t_0} \Rightarrow appl.$

$$\mathbf{t_3} \Rightarrow 3 \text{ months}$$

- $\mathbf{t_6} \Rightarrow 6 \text{ months}$
- $\mathbf{C} \Rightarrow$ Control (no amend.) $SD \Rightarrow$ soil amended with
- solid digestate $LD \Rightarrow$ soil amended with
- liquid digestate
- n = 54 bulk samples

4. Materials & Methods Bulk samples (54):

- bulk density (BD)
- pH and EC
- texture, XRD, ICP-MS
- TG-DSC
- CHNS
- qPCR

SOM fractions (108):

- TG-DSC
- CHNS

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5. Results & Discussion

Elemental and thermal characterization of digestates

		-				TOT	DCC T	\ \ / I	(ower CT mea	in earlie	r appearand	ce and o	orresp	ond to	higher	r number	of targe	t gen	e copi	es). ND	= not
		dm (%)	LOI (%)	C N (%)	C/N		DSC-1 ₅₀ (°C)	WL _{450-550/250-3}	350 C	etectable.			Condi amoA		ting of the w nosZ	hole block (w amoA(A)	ithout 16S) 16S	Conditiona amoA(B)	200-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0-0		by column) amoA(A)	16S
Solid di	gestate	25	85	42 1.4	30	288	352	0.079			Sample C'	Depth (cm) Time 0-15 t _o	32.4	R ROOMSTON	(the lower t 36.30	the more) 30.48	20.57	32.46	CT (the lower th 36.30	e more) 30.48	20.57
	0	25									C"	0-15 t _o	34.7		36.24	31.89	19.73	34.71	29.27	36.24	31.89	19.73
Liquid d	digestate	5	57	33 3.5	9	313	374	0.392			C"	0-15 t ₀ 15-30 t ₀	27.8	C	28.61 34.92	27.05	20.63	27.80 32.83	25.67 30.45	28.61 34.92	27.05 31.83	20.63
ANOVA of	SD and LD	bulk s	ample	s compared	to co	ntrol for	SOC and TN	V stocks.			C" C"	15-30 t ₀ 15-30 t ₀	31.4	5 29.53		30.46 30.09	19.87 19.65	31.45 32.53	29,53 29.09	35.53 34.38	30.46 30.09	19.87 19.65
				Bulk s	ample	25							24 <u></u>		Source Pression							115
				Treatment		Гime	Treatmen	t × Time			C"	0-15 t _a 0-15 t _a	29.4 31.7	-0.00	32.75 34.87	29.94 31.77	20.08 20.41	29.47 31.72	28.85 30.23	32.75 34.87	29.94 31.77	20.08 20,41
	SD:C	Contro									<u>C</u> "	0-15 t ₃	28.8		31,69	27.35	18.00	28,80	26,19	31.69	27.35	18.00
	SOC sto	ock (0-	15)								C"	15-30 t ₃ 15-30 t ₃	ND 33.0	An Anna an Anna an	ND 36.45	ND 33.78	21.67 20.23	ND 33.08	34.43 30.75	ND 36.45	ND 33.78	21.67 20.23
	SOC sto	ock (15-	-30)	0.004**							C**	15-30 t ₃	35.7	29.70	37.55	34.31	19.00	35.70	29.70	37.55	34.31	19.00
	TN sto	ck (0-1	15)								C	0-15 t ₆	35.5	32.90	36.47	33,80	23.86	35.59	32.90	36.47	33,80	23,86
	TN sto	ck (15-	30)	0.001***			0.03	2*			C"	0-15 L ₆	33.7	n ministration	34.85	33.04	21.95	33.78	30.89	34.85		21.95
	LD:C	Contro									<u> </u>	0-15 t ₆ 15-30 t ₆		3 30.14 32.29	33.23 35.59	31.03 32.32	21.45	33.78 ND	30.14	33.23 35.59	31.03 32.32	21.45 22.97
	SOC sto	ock (0-	15)								C"	15-30 t ₆	39.6	2010/00/00	ND	36.56	22.26	39.65	32.09	ND		22.26
	SOC sto	ock (15-	-30)	0.000***							C"	15-30 t ₆	ND	31.37	33.04	ND	23.27	ND	31.37	33.04	ND	23.27
	TN sto	ck (0-1	15)															-				
	TN sto	ck (15-	30)	0.000***			0.00	4**			SD' SD"	0-15 t _o 0-15 t _o	32.0 29.1		32.03 29.26	30.27 28.09	19.65 18.53	32.07	30.10 27.18	32.03 29.26	30.27 28.09	19.65 18.53
	SD and ID	samnl	les con	nared to c	ontrol	for OC a	nd TN stock	ks ratio betwe	en $MAOM$ a	nd POM	SD"	0-15 t _o	28.2			27.13	17.49	28.20	25.73	28.68	27.13	17.49
		Sampi		•							SD' SD"	15-30 t _o 15-30 t _o	34.0 29.8	in the second second	33.26 28.24	31.36 28.40	18.77 18.31	34.00 29.88	28.97 27.24	33.26 28.24	31.36 28.40	18.77 18.31
			_				-	 *			SD"	15-30 t _o	21.3	Contraction of the second	20.70	22.91	15.09	21.33		20.70	22.91	15.09
		:Contr				Time	Treatment	× IIme			SD'	0-15 t ₃	30.0	27.84	29.21	29.90	18.91	30.09	27.84	29.21	29.90	18.91
	OC _{MAOM}						0.000	-L-			SD"	0-15 t ₃	30.7	2 28.62	11/22002/02/07	29.64	19.03	30.72	28.62	31.78	29.64	19.03
	OC _{MAOM} /						0.028	<u>^</u>			SD" SD'	0-15 t ₃ 15-30 t ₃	26.6		26.53 25.33	26.37 26.57	17.62	26.60 26.42	24.51 24.60	26.53 25.33	26.37 26.57	17.62
	TNMAOM		•			.030*	0.010	-1-			SD"	15-30 t ₃	24.1			24.47	15.93	24.11	22.89	22.75	24.47	15.93
	TN _{MAOM} /) 0.009*	* 0.0	000***	0.013	*			SD"	15-30 t ₃	20.6) 20.50	20,10	22.44	14.32	20,60	20.50	20.10	22.44	14.32
		Contro									SD'	0-15 t ₆	32.4	30.41	30.96	31.40	21.77	32.49	30.41	30.96	31.40	21.77
	OC _{MAOM}						0 0 0 7 7	-L			SD"	0-15 t ₆ 0-15 t ₆	28.3			28.21	19.47	28.36		27.41	28.21	19.47
	OC _{MAOM} /						0.037	*			SD'	15-30 t ₆	29.9	7 26.82 3 30.42	Concernance of the second second	28.71 33.36	20.18 20.78	29.97 36.23	26.82 30.42	32.81 39.24	28.71 33.36	20.18
	TN _{MAOM}					009**	/ /	_			SD"	15-30 t ₆	29.8		33,33	28.81	20.09	29.82	28.01	33,33	28.81	20.09
	TN _{MAOM} /	TN _{POM}	(15-30)	0.	.015*	0.011	*			SD	15-30 t ₆	30.0	5 27.47	30.00	29.64	21.22	30.05	27.47	30.00	29.64	21.22
of TG-DSC	indices of	POM a	and M	AOM samp	les of	the thre	e treatment	s (Control, SD	and LD) at	t_2 and at	LD'	0-15 to	29.3	28.02	30,79	28.98	19.54	29.31	28.02	30.79	28.98	19.54
ths (0-15 and									······ ,	-5	LD"	0-15 t _o		29.44		34.29	20.33		29.44	35.49	34.29	20.33
						_					LD"	0-15 t ₀ 15-30 t ₀	27.4	1	27.99 36.10	28.02 32.24	18.24	27.47	26.41 31.14	27.99	28.02 32.24	18.24
	Т	G-T ₅₀ ((°C)	DSC-	۲ _{₅0} (° C `		nergy densi		550/250-350		LD"	15-30 t _o	33.9		33.71	30.55	20.06	33.90	28.89	33.71	30.55	20.06
		50			50 x	· (J mgSOM ⁻¹) 430	550/250-550		LD"	15-30 t _o	35.6	30.30	35.02	33.00	20.67	35.69	30.30	35.02	33.00	20.67
reatment T	ime 0-15	cm 15	5-30 cn	n 0-15 cm	15-30	cm 0-1	5 cm 15-30	cm 0-15 cm	15-30 cm		LD'	0-15 t ₃	31.1		34.46	32.34	21.33	31.18	30.09	34.46	32.34	21.33
Control	t_{2} 343	3	342	352	35 ⁻	1 1	3.4 13.	6 0.42	0.42		LD" LD"	0-15 t ₃ 0-15 t ₃	32.6		38.08 36.10	32.58 29.90	19.65 19.95	32.63 31.74	28.63 28.33	38.08 36.10	32.58 29.90	19.65 19.95
SD	$t_3 = 342$		340	353	357		3.9 13.		0.32		LD'	15-30 t _a	32.6		34.84	31.92	21.81	32.63	31.70	34.84	31.92	21.81
LD	$t_3 = 344$		343	353	354		3.6 13.		0.42		LD" LD"	15-30 t ₃ 15-30 t ₃	30.3 27.1	3 28.71 5 26.88	31,11 30.51	30,11 29,45	18.71 17.90	30.33 27.15	28,71 26.88	31,11 30,51	30.11 29.45	18,71 17,90
Control	$t_3 = 362$		361	355	359		0.4 10.		0.93				47.1	20.00	50.51	27.43	17.90	47.12	20.00	20.21	67. 4 5	17.20
SD	$t_3 = 363$		363	355	360		0.8 11.		0.94		LD' LD"	0-15 t ₆ 0-15 t ₆	32.2 30.2		32.55 31.35	31.82 29.37	22.12 21.01	32.27	30.88	32.55 31.35	31.82 29.37	22.12 21.01
LD	t ₃ 36		360	344	357		2.7 10.		0.92		LD"	0-15 t ₆	34.1		35,75	31.80	21.01	34,18	30,06	35,75	31.80	21.01
											LD'	15-30 L ₆	32.1		33.40	ND	22.02	32.12	30.76	33.40	ND	22.02
lusions											LD" LD"	15-30 t ₆ 15-30 t ₆	33.1 ND	5 32.67 30.95	34.92 ND	34.92 ND	21.87 20.85	33.15 ND	32.67	34.92 ND	34.92 ND	21.87 20,85
	of OC betv	ween F	POM a	nd MAON	l was e	exclusive	ely affected	by solid dige	estate appli	cation; both	treatmo	ents display	yed the	ir inte	ractive	e effect	with time	e. The t	ime f	actor	had an	

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	(70) (70)		0)			(\mathbf{C})								Samala	Depth (cm)	Time
digestate	e 25	5 85	42	1.4	30	288	35	52	С	.079				-	C'	0-15	t _o
0															C"	0-15	t _o
digestat	te 5	57	33	3.5	9	313	51	74	U	.392				-	C'	0-15	t ₀
f SD and		<pre>c camplo</pre>	s com	narod t	o cont	col for		and TN	stock	c					C"	15-30	to
		c sample					300 8		SLOCK	5.				-	C"	15-30	t _o
				Bulk sa			T	44	T					-	C'	0-15	t ₃
			Treat	ment	Tin	ne	Irea	tment	× IIn	1e					C"	0-15	t ₃
	D:Cont													100	C"	0-15	ly Li
	C stock (2													C"	15-30	t ₃
SOC	stock (*	5-30)	0.00)4**										<u>21</u>	C"	15-30	t ₃
TN	stock (C)-15)													C'	0-15	1 ₆
TN	stock (1	5-30)	0.00	1***				0.032	*						C"	0-15	l_6
L	D:Cont	rol												-	C"	0-15	t ₆
SOC	C stock (0-15)													C"	15-30	t ₆
	stock (,	0.00	0***										20 70	C"	15-30	1 ₆
	stock (0			-										00			
	stock (1	,	0.00	O***				0.004*	**					-	SD'	0-15	to
	•					• •								_	SD" SD'''	0-15 0-15	to to
f SD and	LD sam	ples cor	npared	to co	ntrol fo	r OC a	and TN	l stocks	ratio	betw	een	MAOM a	nd POM	1. –	SD'	15-30	to
			Γ	ЛАОМ	/POM										SD"	15-30	t _o
	SD:Con	trol		atmen		ne	Treat	ment ×	Time	9				1075 114	SD"	15-30	t _o
		_{ом} (0-15		.001**										-	SD'	0-15	t3
		_{ом} (15-30		000***				0.028*							SD" SD"	0-15 0-15	t3 ta
				.003**	0.03	20*		0.020						-	SD'	15-30	t ₃
		OM (0-15)	/	.005	0.00			0.013*							SD"	15-30	t3
	LD:Con	_{om} (15-30) 0.	.009	0.000			0.015						.	SD'"	15-30	t ₃
			1											-	SD'	0-15	t ₆
		_{ом} (0-15						0 0 0 7 +							SD" SD"	0-15 0-15	t ₆
		ом (15-30						0.037*						-	SD'	15-30	46 t ₆
		ом (0-15)			0.00										SD"	15-30	t ₆
	$_{OM}/TN_{PC}$	_{ом} (15-30))		0.01	5*		0.011*						121	SD"	15-30	t ₆
						م دام برم		4					± anad	-			
C indices				sample	s or th	e thre	e trea	tments	(CON	1101, S	D an	u LD) at		al	LD' LD"	0-15 0-15	t _o to
nd 15-30	J cm).													<u>.</u>	LD ^m	0-15	t _o
	TA T		_			E	nergy	density						_	LD'	15-30	t _o
	TG-T₅	₀ (°C)		DSC-T ₅	₀ (°C)			SOM ⁻¹)		WL ₄₅	0-550/	250-350			LD" LD"	15-30 15-30	t _o to
_								-		_	_				1999-999 199		
Time 0-	-15 cm	15-30 cr	n 0-1	5 cm 1	5-30 ci	m 0-1	5 cm	15-30 c	cm 0-	-15 cr	n 15	-30 cm			LD' LD"	0-15 0-15	t ₃
t ₃	343	342	3.	52	351	1	3.4	13.6		0.42		0.42		194	LD"	0-15	t _a
t ₃	342	340	3	53	357	1	3.9	13.3		0.37		0.32		-	LD'	15-30	t,
t ₃	344	343	3	53	354	1	3.6	13.3		0.42		0.42			LD" LD"	15-30 15-30	t3 12
t ₃	362	361		55	359		0.4	10.1		0.96		0.93		-			•9
t_3	363	363		55	360		0.8	11.4		0.94		0.94			LD'	0-15	t ₆
t ₃	361	360		44	357		2.7	10.1		0.92		0.92			LD" LD"	0-15 0-15	46 16
L 3	501	500		1 T	551		_ • 1	10.1		J.JL		V.JL		_	LD	15-30	1 ₆
															LD"	15-30	t ₆
														-	LD™	15-30	46

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	(70)	(70)	(70)			(\mathbf{C})					Sample	Depth (cm)) Time
igestate	25	85	42 1.4	30	288	352	0.07	79			C'	0-15	t _o
0	_										C"	0-15	to
digestate	5	57	33 3.5	9	313	374	0.39	92				0-15	t ₀
SD and LD	hulk s	amnlo	compared	to con	trol fo	r SOC and r	TNI stocks				C"	15-30	to
	DUIK S	amples	•			SOC and	Th Stocks.	I			C"	15-30	t _o
				samples		Treatme	nt v Time				C	0-15	t3
	ontrol		Treatment		me	Ireatme	nt × Time	-			C"	0-15 0-15	t _a
											C	15-30	13 13
SOC sto	· ·		0 00 1 * *								C"	15-30	t ₃
SOC sto	•	-	0.004**					-				15-30	ц
TN sto	•	-					2224				C'	0-15	1 ₆
TN stoc	•	-	0.001***			0.0)32*				C" C"	0-15 0-15	t ₆
	ontrol										C'	15-30	t ₆
SOC sto	Ľ	-									C"	15-30 15-30	t ₆
SOC sto	ck (15-	·30)	0.000***					_				15-50	40
TN sto	ck (0-1	5)									SD'	0-15	to
TN stoc	k (15-3	30)	0.000***			0.0	04**	_			SD*	0-15	t _o
SD and LD	sample	es com	npared to d	ontrol f	or OC	and TN sto	cks ratio be	etwee	n MAOM a	ind POM.	SD"	0-15	t _o
			•								SD' SD"	15-30 15-30	to to
CD.	Contra					Trestress	1 Time e				SD"	15-30	to
	Contro				me	Treatmen	t × lime				SD'	0-15	t ₃
OC _{MAOM} /											SD"	0-15	t ₃
OC _{MAOM} /(0.02	28*				SD"	0-15	t3
TN _{MAOM} /)30*						SD' SD"	15-30 15-30	t3 t3
TN _{MAOM} /) 0.009*	* 0.00)0***	0.01	3*				SD"	15-30	t ₃
LD:	Contro	ol									SD'	0-15	ts
OC _{MAOM} /	OC _{POM}	(0-15)									SD"	0-15	t ₆
OC _{MAOM} /(DC _{POM}	(15-30)			0.03	87*				SD" SD'	0-15	t ₆
TN _{MAOM} /	TN _{POM}	(0-15)		0.0	09**						SD"	15-30	t ₆
TN _{MAOM} /				0.0)15*	0.01	1*				SD"	15-30	t ₆
											31		
indices of		and M/	AOM samp	ples of t	he thre	e treatmei	nts (Contro	ol, SD a	and LD) at	t_3 and at	LD'	0-15	t _o
id 15-30 cm	ı).										LD" LD"	0-15 0-15	to to
					E	nergy den	sitv				LD'	15-30	to
T	G-T ₅₀ ((° C)	DSC-	T ₅₀ (°C)		(J mgSON		′ L₄₅₀₋₅₅	0/250-350		LD" LD"	15-30 15-30	t _o
						-	-	_				15-50	40
Гіте <mark>0-15</mark> (cm 15	-30 cn	า 0-15 cm	15-30	cm 0-1	15 cm 15-3	30 cm 0-15	5 cm '	15-30 cm		LD'	0-15	t3
t ₃ 343	}	342	352	351		13.4 1	3.6 0.4	42	0.42		LD" LD"	0-15 0-15	t ₃
t ₃ 342)	340	353	357	-	13.9 1	3.3 0.3	37	0.32		LD'	15-30	t,
$t_3 = 344$		343	353	354	-		3.3 0.4	42	0.42		LD" LD"	15-30 15-30	ta Ia
t ₃ 362		361	355	359			0.1 0.9		0.93				-
$t_3 = 363$		363	355	360			1.4 0.9		0.94		LD'	0-15	t ₆
$t_3 = 361$		360	344	357			0.1 0.9		0.92		LD" LD"	0-15 0-15	46 46
				551			<u> </u>	- -			LD'	15-30	4,
											LD"	15-30	t ₆
											LD"	15-30	46

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		(70)	(70)	(70)			(\mathbf{C})					Sample	Depth (cm	a) T
Solid (digestate	25	85	42 1	.4 30	288	3	52	0.079			C'	0-15	9 1
Liquid	digestate	5	57	33 3	.5 9	313	3.	74	0.392			C" C"	0-15 0-15	
LIQUIU	uigestate	5	51			515	5	/ 4	0.592			C'	15-30	
	f SD and LD) hulk s	amples	compa	ared to a	ontrol fo	or SOC	and TN sto	ocks			C"	15-30	
			ampies	•	lk samp								15-30	
			-	Freatm		Time	Troa	atment × 1	Timo			C	0-15	
		Contro		reatin		IIIIE						C" C"	0-15 0-15	
												C	15-30	T
		ock (0-		0 00 4	k-k							C"	15-30	
	SOC sto	•	-	0.004									15-30	_
		ock (0-1	,									C	0-15	
	TN sto	ck (15-	30)	0.001*	**			0.032*				C"	0-15 0-15	
	LD:0	Contro										<u>C</u>	15-30	+
	SOC st	ock (0-	15)									C"	15-30	
	SOC sto	ock (15-	-30)	0.000*	**							C"	15-30	
		ck (15-	,	0.000*	**			0.004**				SD'	0-15	
		•	-									SD" SD"	0-15 0-15	
ANOVA 01	f SD and LD	sampi	es com	pared	o contro	of for OC	and Ir	N STOCKS ra	tio betwee	en MAOM a	ING POM.	SD'	15-30	1
				M	AOM/PO	OM						SD" SD"	15-30 15-30	
	SD	:Contr	ol	Treat	ment	Time	Treat	ment × Ti	me			30	15-50	_
	OC _{MAOM}		(0-15)	0.0	D1**							SD'	0-15	
)0***			0.028*				SD" SD"	0-15 0-15	
	TN _{MAOM}					0.030*						SD'	15-30	1
	TN _{MAOM}		•			0.000***		0.013*				SD"	15-30	
		Contro				5.000		0.015				SD"	15-30	
												SD'	0-15	
	OC _{MAOM}		-					0 0 2 7 *				SD" SD"	0-15 0-15	
						0 00044		0.037*				SD'	15-30	1
	TN _{MAOM}		•			0.009**						SD"	15-30	
	TN _{MAOM} /	TN _{POM}	(15-30)			0.015*		0.011*				SD"	15-30	
	C indices of		and MA		mplac c	of tha thr	on tran	tmonte (C	ontrol SD	and (D) at	t and at	L DI	0.15	_
					inpies e						t ₃ and at	LD' LD"	0-15 0-15	
.115 (U-15 al	nd 15-30 cr	11).		_								LD ^m	0-15	
		ст					Energy	density	10/1			LD' LD"	15-30 15-30	
		G-T ₅₀	()		C-T ₅₀ (°	C)		SOM ⁻¹)	WL ₄₅₀₋₅	50/250-350		LD"	15-30	
	T:	4 6		0.15	4 5 7		45	15 20	0.15	15 20			0.15	_
	11me U-15	cm 15	-30 cm	0-15	cm 15-3		ID CM	12-20 cm	0-15 cm	13-30 CM		LD' LD"	0-15 0-15	
reatment	t ₃ 34	3	342	352	. 3	51	13.4	13.6	0.42	0.42		LD"	0-15	
reatment Control		2	340	353	3	57	13.9	13.3	0.37	0.32		LD'	15-30	
	$t_3 = 34$		212	353	3	54	13.6	13.3	0.42	0.42		LD" LD"	15-30 15-30	
Control		4	343			59	10.4	10.1	0.96	0.93				_
Control SD	$t_3 = 34$		361	355	· 3				1			LD'	0-15	
Control SD LD	$t_3 = 34$ $t_3 = 34$ $t_3 = 36$ $t_3 = 26$	2	361				10.8	11.4	0.94	0.94				
Control SD LD Control SD	$t_3 = 34$ $t_3 = 34$ $t_3 = 36$ $t_3 = 36$	2 3	361 363	355	3	60						LD" LD"	0-15 0-15	
SD LD Control	$t_3 = 34$ $t_3 = 34$ $t_3 = 36$ $t_3 = 26$	2 3	361		3		10.8 12.7	11.4 10.1	0.94 0.92	0.94 0.92		LD"	0-15	
Control SD LD Control SD	$t_3 = 34$ $t_3 = 34$ $t_3 = 36$ $t_3 = 36$	2 3	361 363	355	3	60						LD" LD"	0-15 0-15	

6. C

The distribution of OC between POM and MAOM was exclusively affected by solid digestate application; both treatments displayed their interactive effect with time. The time factor had an evident influence after the application of both digestates on the TN_{MAOM}/TN_{POM} ratio.

OM accumulated more in the POM fraction after solid digestate amendment, while the distribution between SOM pools following liquid digestate application was similar to control. In low-OC content soils, the interaction between SOM and mineral surfaces is the major SOM stabilization mechanism.

Quantitative PCR showed that solid digestate application increased total microbial abundance (16S) and the quantity of genes related to the N cycle, especially at 15-30 cm and at t₃.







Cycle thresholds (CT) of qPCR for the five genes investigated in the DNA extracted from soils. The conditional formatting (green through red) allows to appreciate the differences in gene abundance (lower CT mean earlier appearance and correspond to higher number of target gene copies). ND = not

