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Soil Research

Supplementary Material

Effects of biobased fertilisers on soil physical, chemical and biological indicators – a one-year incubation study

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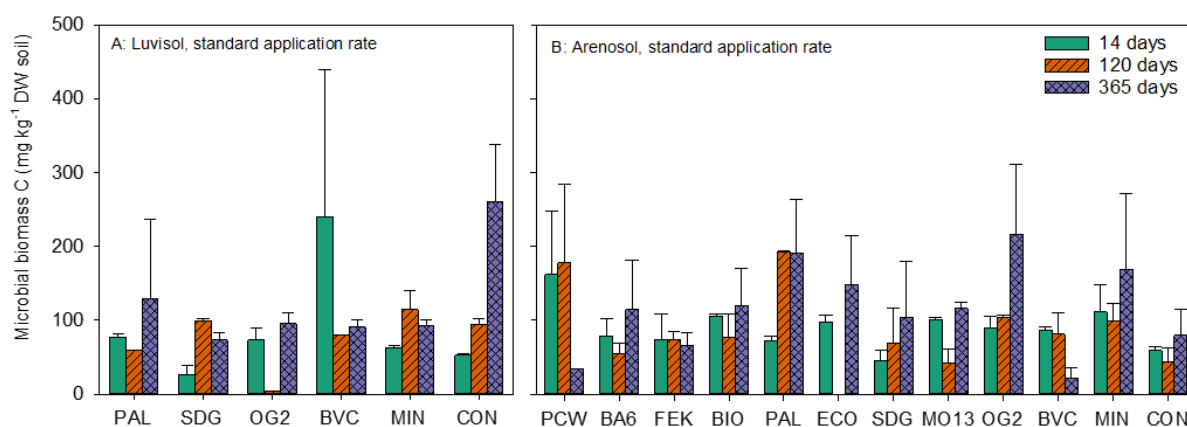


Figure S1: Microbial biomass C (mg g dry-weight soil⁻¹). Luvisol soil standard application rate (A), Arenosol soil standard application rate (B). Values are means \pm standard error for samples taken at three time points during the incubation period: 14 days, 120 days and 365 days after the start of incubation. BA6, BIO, BVC, ECO, FEK, MO13, OG2, PAL and SDG are biobased fertilisers, MIN is a reference mineral fertiliser and CON is the negative control. N=1 for BVC 120 days, OG2 120 days, PAL 120 days (A), PCW 365 days (B). N=2 for OG2 14 days, SDG 14 days, SDG 120 days, MIN 120 days, CON 120 days, OG2 365 days (A), SDG 14 days, MIN 14 days, BVC 120 days, FEK 120 days, OG2 120 days, PAL 120 days, SDG 120 days, SDG 365 days (B). For all others, N=3.

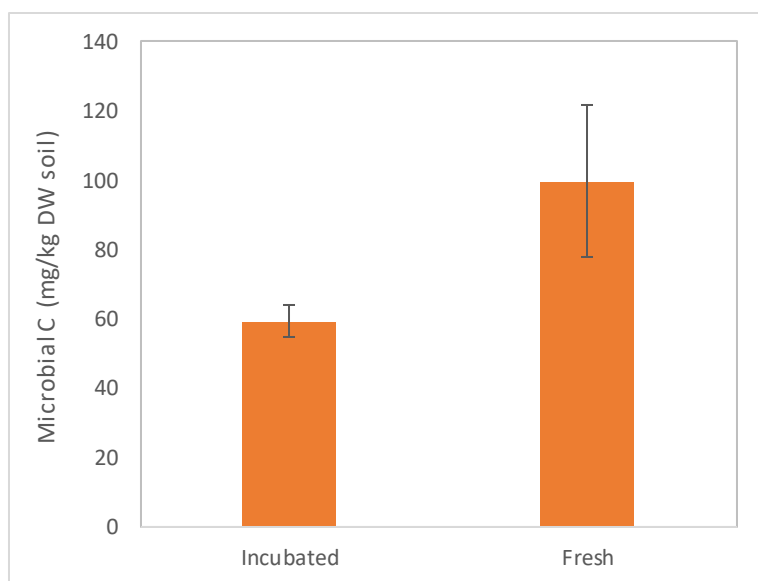


Figure S2: Microbial biomass C (mg g dry-weight soil⁻¹) for the Arenosol soil negative control (CON) 14 days after the start of incubation (Incubated) and a non-treated freshly sampled Arenosol soil from the same field. Values are means \pm standard error, N=3.

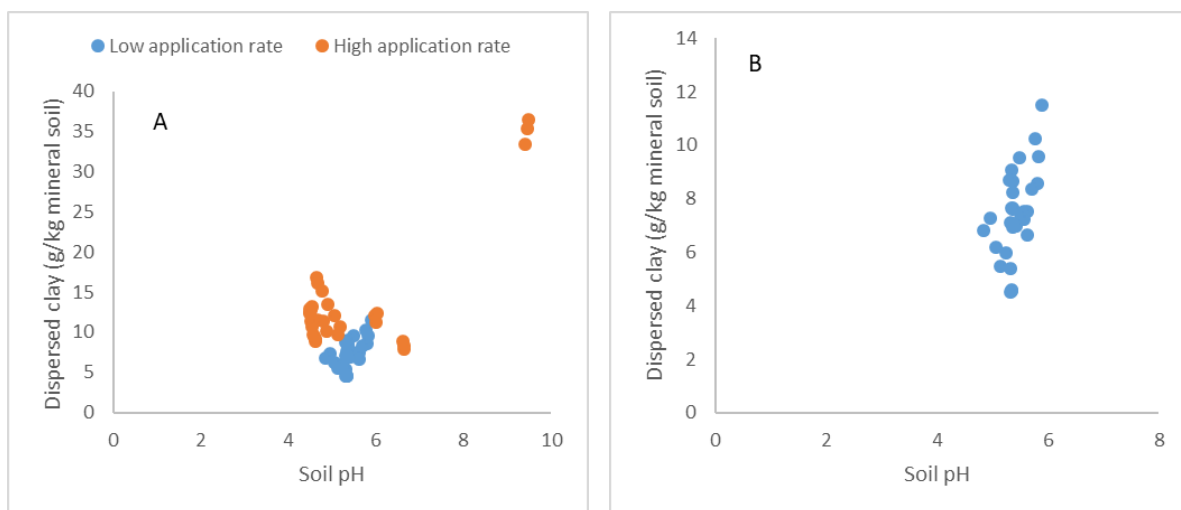


Figure S3: Relationship between clay dispersibility (g clay / kg mineral soil) and soil pH (1.5 in CaCl₂) for the BBF treatments at the accelerated and standard application rate (A) and the standard application rate only (B).

Table S1: BBF acronyms (three letters/numbers), full product names and manufacturer names. The data are from Wester-Larsen et al. (2022).

BBF	BBF	Manufacturer
BA6	Bioagenasol	Agrana, A
BIO	Bio 8-4-2 yara	YARA, FI
ECO	Ecolan	Ecolan Oy
FEK	Fertikal	Fertikal, BE
MO13	Monterra bio 13-0-0	MeMon, NL
OG2	Øgro N14	Daka
PAL	Palaterra	Palaterra Betriebs- und Beteiligungsgesellschaft mbH, DE
BVC	Biovækst compost	Biovækst
PCW	AKV K2	AKV
SDG	Solrød digestate	Solrød Biogas

Table S2: Output of statistical analyses showing p-values of Bonferroni-adjusted pairs of estimated marginal means to test differences between treatments 14 days, 120 days and 365 days after the start of incubation on the Arenosol soil for the standard and accelerated application rate. Only significant (P<0.05) results are shown.

		14 days						120 days						365 days							
		Standard application rate			Accelerated application rate			Standard application rate			Accelerated application rate			Standard application rate			Accelerated application rate				
		CEC	pH	WHC	CEC	pH	WHC	pH	WHC	pH	WHC	CEC	Clay dispersibility	pH	WHC	Total C	CEC	Clay dispersibility	pH	WHC	Total C
CON	PCW				0.001	<0.001			0.001	<0.001			0.001					<0.001	<0.001		
CON	BA6				0.003	<0.001			0.003	<0.001	0.002		<0.001				0.002	<0.001	<0.001		
CON	FEK					<0.001					<0.001							<0.001			<0.001
CON	BIO					<0.001												<0.001	<0.001		
CON	PAL									<0.001	<0.001							<0.001	<0.001		<0.001
CON	ECO					<0.001	0.001											<0.001	<0.001		
CON	SDG	<0.001						<0.001	<0.001					<0.001				<0.001	<0.001		0.001
CON	MO13					0.001			<0.001	<0.001			<0.001		<0.001			<0.001	<0.001	<0.001	0.001
CON	OG2						<0.001	0.001		<0.001	0.002			0.002				<0.001	<0.001		
CON	BVC				<0.001	<0.001	<0.001		0.003	0.002	<0.001		<0.001					0.001	<0.001	<0.001	<0.001
CON	MIN													0.004							
PCW	BA6					<0.001	0.002				<0.001							<0.001	<0.001		
PCW	BIO					<0.001					<0.001							<0.001	<0.001		
PCW	BVC					<0.001	<0.001				<0.001	<0.001						<0.001	<0.001	<0.001	<0.001
PCW	ECO				0.001	<0.001	0.004				<0.001							<0.001	<0.001		0.004
PCW	FEK					<0.001					<0.001	0.004						<0.001	<0.001		<0.001
PCW	MIN				<0.001	<0.001					<0.001		0.001					<0.001	<0.001		
PCW	MO13				0.004	<0.001			<0.001	<0.001			<0.001		<0.001			<0.001	<0.001	<0.001	0.001
PCW	OG2					<0.001	<0.001	<0.001	0.002	<0.001			<0.001	0.004	0.001			<0.001	<0.001		
PCW	PAL					<0.001			0.001	<0.001	<0.001							<0.001	<0.001		<0.001
FEK	BA6										<0.001						0.001	<0.001	<0.001		<0.001
FEK	BIO							<0.001										0.003	<0.001		<0.001
FEK	BVC					<0.001	<0.001				<0.001		<0.001					<0.001	<0.001	<0.001	<0.001
FEK	ECO					<0.001	<0.001				<0.001							<0.001	<0.001		<0.001
BIO	BA6					<0.001	<0.001	<0.001		<0.001								0.001	<0.001		<0.001
PAL	BA6					<0.001					0.001						<0.001	<0.001			<0.001
PAL	BIO					<0.001		<0.001		<0.001							<0.001	<0.001	<0.001		<0.001
PAL	BVC	<0.001			0.002	<0.001	<0.001			<0.001	<0.001		<0.001	0.001				<0.001	<0.001	<0.001	<0.001
PAL	ECO					<0.001	<0.001				<0.001							<0.001	<0.001		<0.001
PAL	FEK					<0.001					<0.001							<0.001			
PAL	MIN					<0.001					<0.001							<0.001	<0.001		<0.001
PAL	MO13					<0.001	0.001		<0.001				<0.001		<0.001			<0.001		<0.001	<0.001
PAL	OG2						<0.001						0.001					<0.001			<0.001
ECO	BA6						<0.001											<0.001		<0.001	
ECO	BIO									<0.001								<0.001			
ECO	BVC	<0.001			<0.001		<0.001			<0.001	<0.001		<0.001	0.001				<0.001	<0.001	<0.001	<0.001
SDG	BA6	<0.001				<0.001				<0.001			0.001					0.001	<0.001		

SDG	BIO	<0.001		<0.001	<0.001	<0.001		0.003		<0.001	0.002			
SDG	BVC	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001		<0.001	<0.001	<0.001
SDG	ECO	0.003		<0.001	<0.001	<0.001	<0.001	0.003		0.004				
SDG	FEK	<0.001		<0.001			0.001			<0.001		<0.001		<0.001
SDG	MIN						0.003					<0.001	<0.001	<0.001
SDG	MO13	<0.001		0.004	<0.001	<0.001	<0.001	<0.001	0.004	<0.001	<0.001	0.001		<0.001
SDG	OG2				<0.001			0.001	<0.001					
SDG	PAL			0.001			0.004	0.001	<0.001		0.003			<0.001
SDG	PCW	<0.001		<0.001		<0.001		<0.001	<0.001	0.003	<0.001	<0.001	<0.001	0.001
MO13	BA6			<0.001	<0.001			<0.001		<0.001	<0.001	<0.001		<0.001
MO13	BIO			<0.001				<0.001	<0.001	<0.001	<0.001	<0.001	0.003	
MO13	BVC		<0.001		<0.001			<0.001	<0.001	<0.001		<0.001	<0.001	<0.001
MO13	ECO							<0.001		<0.001	<0.001			
MO13	FEK			<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001
MO13	MIN							<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
OG2	BA6			<0.001	<0.001					0.00	<0.001	0.001		
OG2	BIO			<0.001		<0.001		<0.001		0.001		<0.001	0.001	
OG2	BVC	<0.001	0.001	<0.001	<0.001			<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
OG2	ECO			<0.001			0.004			<0.001				
OG2	FEK			<0.001	<0.001			<0.001		0.001			<0.001	<0.001
OG2	MIN							<0.001				<0.001	<0.001	0.003
OG2	MO13			<0.001			0.002	<0.001			<0.001			<0.001
BVC	BA6			0.003	<0.001			<0.001	<0.001	0.00	0.001	<0.001	<0.001	<0.001
BVC	BIO		0.002		<0.001		0.001		<0.001			<0.001	<0.001	<0.001
MIN	BA6		0.003	<0.001	0.002			<0.001		<0.001		<0.001	<0.001	0.003
MIN	BIO			<0.001		<0.001						<0.001	<0.001	
MIN	BVC	<0.001	<0.001	<0.001	<0.001			0.002	<0.001	<0.001	<0.001		<0.001	<0.001
MIN	ECO			<0.001				<0.001					<0.001	
MIN	FEK			<0.001								<0.001		<0.001

Table S3: Output of statistical analyses showing p-values of Bonferroni-adjusted pairs of estimated marginal means to test differences between treatments 14 days, 120 days and 365 days after the start of incubation on the Luvisol soil for the standard and accelerated application rate. Only significant (P<0.05) results are shown.

		14 days						120 days				365 days										
		Standard application rate			Accelerated application rate			Standard application rate		Accelerated application rate		Standard application rate			Accelerated application rate							
		CEC	pH	WHC	CEC	pH	WHC	pH	WHC	pH	WHC	CEC	Clay disper-sibility	pH	WHC	Total C	CEC	Clay disper-sibility	pH	WHC	Total C	
CON	PAL						<0.001		<0.001	<0.001	0.001		0.001					<0.001	<0.001		<0.001	
CON	SDG		0.002									0.001		<0.001	<0.001			<0.001	<0.001		<0.001	
CON	OG2						<0.001					0.002	0.002	<0.001				<0.001	<0.001		<0.001	
CON	BVC				<0.001	<0.001						0.004	0.003	<0.001	0.001				0.007	0.004	<0.001	<0.001
CON	MIN		0.001										0.001		0.010			<0.001	0.003		<0.001	
PAL	BVC		<0.001		<0.001	<0.001	<0.001							<0.001	<0.001		0.005		<0.001	<0.001	0.001	
PAL	MIN						<0.001					0.007		<0.001				<0.001	<0.001		<0.001	
PAL	OG2											<0.001						<0.001			<0.001	
SDG	BVC		<0.001		<0.001	<0.001						<0.001		<0.001			0.001		<0.001	<0.001	<0.001	
SDG	MIN													<0.001	0.001			<0.001	<0.001		<0.001	
SDG	OG2					0.002	<0.001							<0.001	<0.001			<0.001			<0.001	
SDG	PAL						0.001		<0.001		<0.001		<0.001	<0.001				<0.001	<0.001		<0.001	
OG2	BVC		<0.001		<0.001	<0.001	<0.001		<0.001		<0.001			0.006	<0.001		0.002	<0.001	<0.001	<0.001	<0.001	
OG2	MIN				<0.001	<0.001								<0.001				<0.001	<0.001		<0.001	
MIN	BVC		<0.001		<0.001	<0.001			<0.001		<0.001			<0.001	<0.001		<0.001	<0.001	<0.001	<0.001	<0.001	

Table S4: Output of statistical analyses showing p-values of Tukey-adjusted pairs of estimated marginal means to test differences between C fractions 14 days and 365 days after the start of incubation. Only significant ($P < 0.05$) results are shown.

		Standard application rate			Accelerated application rate		
		POM _{large}	POM _{small}	MAOM	POM _{large}	POM _{small}	MAOM
Luvisol soil	PAL				<0.01		0.02
	SDG		0.01	0.04			
	OG2	0.02	<0.01		<0.01		0.04
	BVC				<0.01		0.02
	MIN						
Arenosol soil	PCW						
	BA6				<0.01		0.04
	FEK						
	BIO						
	PAL				0.05		<0.01
	ECO						
	SDG	0.01	<0.01	<0.01	0.03		
	MO13						
	OG2	0.04					
	BVC						0.04
MIN							