



Supplement of

Complex soil food web enhances the association between N mineralization and soybean yield – a model study from long-term application of a conservation tillage system in a black soil of Northeast China

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2 **Table S1** Soil bulk density (g cm^{-3}) under different tillage practices during the
3 growing season of soybean.

		Soil bulk density (g cm^{-3})						
	Treatment	April	May	June	July	August	September	Mean
0–5 cm	CT	1.06 (0.07)	1.08 (0.02)	1.15 (0.04)	1.25 (0.02)	1.36 (0.05)	1.42 (0.03)	1.22 a (0.10)
	RT	1.00 (0.04)	1.05 (0.02)	1.10 (0.04)	1.16 (0.05)	1.22 (0.06)	1.27 (0.02)	1.13 b (0.09)
	NT	0.96 (0.05)	1.09 (0.03)	1.11 (0.03)	1.19 (0.05)	1.23 (0.06)	1.28 (0.01)	1.14 b (0.11)
5–15 cm	CT	1.11 (0.08)	1.13 (0.07)	1.14 (0.07)	1.22 (0.05)	1.30 (0.04)	1.30 (0.01)	1.20 b (0.09)
	RT	1.23 (0.01)	1.25 (0.01)	1.26 (0.02)	1.33 (0.01)	1.38 (0.02)	1.40 (0.02)	1.31 ab (0.07)
	NT	1.27 (0.03)	1.32 (0.05)	1.30 (0.03)	1.37 (0.04)	1.42 (0.03)	1.42 (0.02)	1.35 a (0.06)

4 CT, conventional tillage; RT, reduced tillage; NT, no tillage.

Table S2 Nematode taxa identified from different tillage practices across sampling dates and soil depths.

Bacterivores	Fungivores	Plant parasites	Omnivores-predators
<i>Acrobeles</i>	<i>Aphelenchoides</i>	<i>Amplimerlinius</i>	<i>Bathyodontus</i>
<i>Acrobeloides</i>	<i>Aphelenchus</i>	<i>Axonchium</i>	<i>Clarkus</i>
<i>Alaimus</i>	<i>Diphtherophora</i>	<i>Basiria</i>	<i>Discolaimus</i>
<i>Cephalobus</i>	<i>Filenchus</i>	<i>Boleodorus</i>	<i>Dorydorella</i>
<i>Cervidellus</i>	<i>Paraphelenchus</i>	<i>Cephalenchus</i>	<i>Enchodelus</i>
<i>Chiloplacus</i>	<i>Tylencholaimus</i>	<i>Coslenchus</i>	<i>Epidorylaimus</i>
<i>Diplogasteritus</i>		<i>Helicotylenchus</i>	<i>Eudorylaimus</i>
<i>Domorganus</i>		<i>Heterodera</i>	<i>Laimydorus</i>
<i>Plectus</i>		<i>Longidorus</i>	<i>Mesodorylaimus</i>
<i>Prismatolaimus</i>		<i>Macroposthonia</i>	<i>Microdorylaimus</i>
<i>Rhabditis</i>		<i>Malenchus</i>	<i>Prodorylaimus</i>
<i>Teratocephalus</i>		<i>Neopsilenchus</i>	<i>Pungentus</i>
<i>Tylopharynx</i>		<i>Ogma</i>	<i>Sectonema*</i>
		<i>Paratylenchus</i>	<i>Thonus</i>
		<i>Pratylenchus</i>	
		<i>Psilenchus</i>	
		<i>Rotylenchus</i>	
		<i>Tylenchus</i>	
		<i>Xiphinema*</i>	

* represents nematode genus only present in 5-15 cm depth across different tillage practices and sampling dates.

Table S3 Soil meso-faunal taxa identified from different tillage practices across sampling dates and soil depths.

	Feeding type	Groups	Species
Mites	Fungivores	Oribatida mites	<i>Ramusella sengbuschi</i> <i>Macquarioppia sp.1</i>
	Fungivores	Prostigmatic mites	<i>Bdella sp.1</i>
	Predators	Mesostigmatid mites	<i>Hypoaspis sp.1</i> <i>Sejidae. sp.</i>
Collembolans	Fungivores	Onychiuridae	<i>Protaphorura armata</i> <i>Allonychiurus songi</i>
	Omnivorous	Others	<i>Tomocerus nigrus</i> <i>Orchesellides sinensis</i> <i>Lepidocyrtus felipei</i> <i>Isotomiella minor</i> <i>Homidia phjongiangica</i>

Table S4 Mean abundance (expressed as individuals m⁻²) of the identified taxa of soil fauna under different tillage practices over the soybean growing season (means (SD)).

	Feeding guild	0-5 cm			5-15 cm			ANOVA		
		CT	RT	NT	CT	RT	NT	Tillage (T)	Depth (D)	T × D
Nematodes	Bacterivores	51794 (10904)	89847 (10974)	102695 (36194)	46811 (10247)	75334 (4121)	117392 (14001)	< 0.001	ns	ns
	Fungivores	54021 (5000) a	30789 (3607) b	38990 (6748) ab	46818 (8791) b	47414 (3947) b	76095 (14462) a	0.004	0.001	0.001
	Plant parasites	52889 (5930)	69762 (20981)	85470 (13180)	90778 (18486)	100303 (18842)	111569 (19820)	0.02	< 0.001	ns
	Omnivores-predators	12562 (2251) a	11004 (6940) a	13250 (4256) a	24644 (4556) b	32689 (6011) b	68449 (9515) a	< 0.001	< 0.001	< 0.001
Mites	Fungivores	5746 (1271)	11558 (3803)	13101 (4404)	2731 (201)	4294 (674)	3631 (1797)	0.008	< 0.001	ns
	Predators	341 (70)	680 (388)	860 (401)	169 (114)	189 (105)	158 (205)	ns	< 0.001	ns
Collembolans	Fungivores	2480 (1831)	3989 (2384)	4133 (1517)	1159 (91)	1543 (668)	1606 (599)	ns	0.002	ns
	Omnivores	1546 (464)	2322 (744)	2071 (589)	565 (387)	744 (547)	689 (188)	0.040	0.001	ns

CT, conventional tillage; RT, reduced tillage; NT, no tillage; two-way ANOVA was used to test the effect of tillage and soil depth on the variables. When significant interaction occurred, the pairwise differences between CT and RT and NT were tested with Tukey's honestly significant difference at each soil depth; ns indicates no significant difference ($P > 0.05$); same lowercase letter in the same row and same depth indicates no significant difference among tillage systems ($P > 0.05$).

Table S5 The density independent feeding preference¹ for each predator trophic group.

Predator trophic group	Prey trophic groups	Density independent feeding preference
Bacteria	Detritus	1
Fungi	Detritus	1
Herbivorous nematodes	Root	1
Herbivorous collembolans	Root	1
Bacterivorous nematodes	Bacteria	0.95
Bacterivorous collembolans	Bacteria	1
Fungivorous nematodes	Fungi	0.8
Fungivorous collembolans	Fungi	0.95
Fungivorous mites	Fungi	1
Omnivorous-predaceous nematodes	Herbivorous nematodes	0.2
	Bacterivorous nematodes	0.2
	Fungivorous nematodes	0.2
Predaceous collembolans	Herbivorous nematodes	0.05
	Bacterivorous nematodes	0.05
	Fungivorous nematodes	0.05
	Omnivorous-predaceous nematodes	0.8
	Herbivorous collembolans	0.05
	Bacterivorous collembolans	0.05
	Fungivorous collembolans	0.05
Predaceous mites	Herbivorous nematodes	0.1
	Bacterivorous nematodes	0.1
	Fungivorous nematodes	0.1
	Omnivorous-predaceous nematodes	0.1
	Fungivorous mites	0.2
	Herbivorous collembolans	0.2
	Bacterivorous collembolans	0.2
	Fungivorous collembolans	0.2
	Predaceous collembolans	0.2

¹, source from de Ruiter et al. (1993), de Vries et al., (2013), Didden et al. (1994) and Schwarz et al. (2017).

Table S6 Values of the physiological parameters¹ used to calculate the N of the soil food web.

Trophic groups	C:N	Assimilation efficiency	Production efficiency	Death rate (year ⁻¹)
Root ²	7.5	-	-	-
Detritus ³	12			
Bacteria	5	1.00	0.30	9
Fungi	10	1.00	0.44	3.7
Herbivorous nematodes	10	0.42	0.31	2.3
Herbivorous collembolans	8	0.34	0.37	1.96
Bacterivorous nematodes	10	0.54	0.49	14.1
Bacterivorous collembolans	8	0.34	0.37	1.96
Fungivorous nematodes	10	0.42	0.31	6
Fungivorous collembolans	8	0.34	0.37	1.96
Fungivorous mites	8	0.50	0.40	1.42
Omnivorous-predaceous nematodes	10	0.55	0.28	5.8
Predaceous collembolans	8	0.34	0.37	1.96
Predaceous mites	8	0.75	0.30	3.44

¹, source from de Vries et al. (2013); ², the C:N ratio of the cytoplasm of plant cells (Verschoor et al., 2002); ³, the C:N ratio of detritus measured in our lab.

1 **Table S7** The cumulative amount of mineral N delivered by soil food webs (expressed as mg N m⁻² year⁻¹) over the soybean growing season
 2 under different tillage practices (means (SD)).

Pathway	Feeding guild	0-5 cm			5-15 cm			ANOVA		
		CT	RT	NT	CT	RT	NT	Tillage (T)	Depth (D)	T × D
Root pathway	Total Nmin	52.55 c (2.80)	63.30 b (3.28)	75.95 a (4.76)	140.50 a (27.74)	118.40 a (7.21)	159.77 a (23.46)	< 0.001	< 0.001	0.020
	Nmin (roots→herbivores)	41.69 (3.25)	53.16 (2.69)	61.6 (3.19)	72.29 (7.72)	77.35 (4.38)	86.09 (12.00)	< 0.001	< 0.001	ns
	Nmin (herbivores→predators)	10.85 (2.40)	10.15 (0.78)	14.30 (2.22)	68.21 (20.22)	41.04 (8.95)	73.68 (13.67)	0.003	< 0.001	ns
Bacterial pathway	Total Nmin	4517.74 (353.44)	5855.59 (307.55)	6425.15 (916.86)	6550.21 (970.00)	8830.57 (145.38)	9565.72 (438.29)	< 0.001	< 0.001	ns
	Nmin (detritus→bacteria)	4271.71 (349.71)	5205.55 (257.29)	5951.09 (822.55)	6314.26 (954.98)	8457.56 (103.94)	8979.14 (512.34)	< 0.001	< 0.001	ns
	Nmin (bacteria→bacterivores)	225.41 b (30.23)	622.04 a (46.52)	449.51 a (133.83)	186.04 c (40.46)	296.38 b (36.76)	428.84 a (47.20)	< 0.001	< 0.001	0.002
	Nmin (bacterivores→predators)	20.62 a (3.70)	24.54 a (10.27)	28.00 a (2.52)	49.91 b (11.11)	76.64 ab (20.63)	157.71 a (74.42)	0.002	< 0.001	0.013
Fungal pathway	Total Nmin	5447.57 (436.59)	7434.05 (551.69)	7646.12 (794.07)	6537.00 (302.66)	7949.78 (990.23)	8468.86 (313.37)	< 0.001	0.007	ns
	Nmin (detritus→fungi)	5421.75 (433.21)	7402.99 (542.76)	7613.55 (798.64)	6509.06 (299.44)	7919.58 (521.04)	8414.91 (325.48)	< 0.001	0.007	ns
	Nmin (fungi→fungivores)	20.09	25.49	26.74	17.32	21.53	29.44	0.003	ns	ns

	(4.24)	(6.92)	(4.11)	(1.00)	(4.57)	(4.25)			
Nmin (fungivores→predators)	5.72	5.57	5.83	10.61	8.68	24.52	0.034	< 0.001	ns
	(2.13)	(2.58)	(2.13)	(3.99)	(3.83)	(10.89)			
Total mineralized N in the food web	10017.85	13352.94	14147.22	13227.71	16898.76	18194.35	< 0.001	< 0.001	ns
	(789.55)	(687.93)	(1549.39)	(1065.70)	(1177.10)	(568.77)			

3 **Detritus and roots are the basal resources that provide energy to microbial pathway and root pathway, respectively.** CT, conventional tillage; RT, reduced tillage; NT,
4 no tillage; Nmin(i→j) indicates the mineral N delivered by the predation of j on i. Two-way ANOVA was used to test the effect of tillage and soil depth on the
5 variables; when significant interaction occurred, the pairwise differences between CT and RT and NT were tested with Tukey's honestly significant difference at each
6 soil depth; ns indicates no significant difference ($P > 0.05$); same lowercase letter in the same row and same depth indicates no significant difference among tillage
7 systems ($P > 0.05$).

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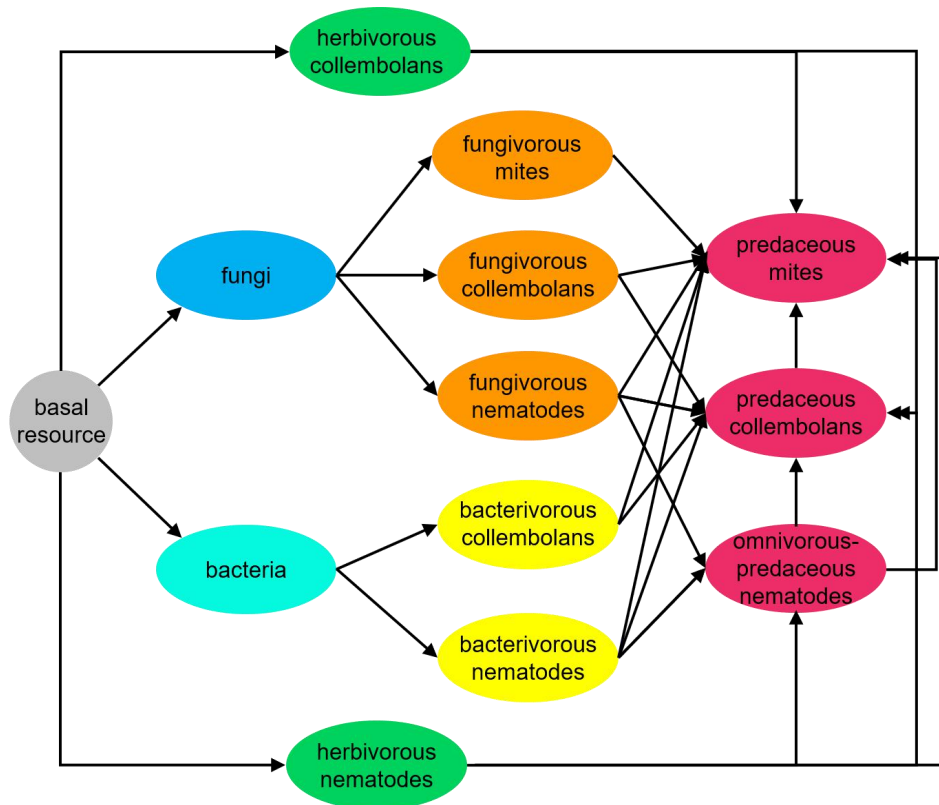


Figure S1. Soil food web diagram presenting the feeding relationships among different trophic groups. Omnivorous collembolans were assigned in equal proportions to bacterivorous, fungivorous, herbivorous and predaceous collembolans according to their dietary proportion (de Vries et al., 2013). Colors indicate different feeding guilds: light blue = bacteria, dark blue = fungi, green = herbivorous feeders, yellow = bacterivorous feeders, orange = fungivorous feeders, maroon = predaceous feeders. The gray circle represents basal resources provided by detritus and roots.

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