Data Article

Data on soil physicochemical properties and biodiversity from conventional, organic and organic mulch-based cropping systems.

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A R T I C L E   I N F O

A B S T R A C T

The data presented here are related to the article entitled "Soil functions are affected by transition from conventional to organic mulch-based cropping system"[1]. Data were collected in 2016 in a processing tomato field located near Perugia, Italy. In details, data were collected in three differently managed processing tomato cropping systems: conventional integrated (INT); traditional organic with cover crops and conventional tillage (ORG); and organic coupled with conservation agriculture, with mulch-based cover crop and no-tillage (ORG+). We report data on the impact of each cropping system on crop biomass and yield, soil physicochemical properties, size and structure of soil microbial community, soil invertebrate biodiversity and habitat provision (predator-prey trophic interactions).

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Specifications Table

Subject	Agricultural and Biological Sciences (General)
Specific subject area	Effects of the cropping systems management on soil physicochemical features and invertebrate biodiversity
Type of data	Table
	Image
	Figure
How data were acquired	Soil survey, Agilent 7890-A gas-chromatograph, DNA extraction, BioRad c1000 thermocycler, SANGER sequencing, MEGA 7.
Data format	Raw
	Analyzed
Parameters for data collection	All soil samples were air-dried and sieved through a 2-mm mesh for: particle size distribution, pH in water (pH_{H2O}), available P (Pav), content of total organic C (TOC), water extractable organic C (WEOC), microbial biomass C (Cmic), amount of CO_2 evolved during basal respiration experiments (Res) and invertebrates collected. An aliquot of soil samples stored at 4°C was used for phospholipid fatty acids (PLFA).
Description of data collection	Meteorological data: meteorological station placed inside FieldLab-DSA3.
	Agronomical data: field samplings; suction cup lysimeters.
	Soil data: a soil profile was dug within each plot (2 plot x 3 treatment=6 profiles) to a depth of at least 90 cm and its morphology described. From each profile, the Ap 1 horizon was sampled and carried in a portable refrigerator to the laboratory.
	Invertebrate data: field/soil samplings; Tullgren funnels; Pitfall traps; Molecular gut-content analysis; DNA barcoding.
Data source location	FieldLab-DSA3, Papiano (Perugia), Italy (42°57' N, 12°22' E)
Data accessibility	With the article
Related research article	[1] Massaccesi, L., Rondoni, G., Tosti, G., Conti, E., Guiducci, M., Agnelli, A., Soil functions are affected by transition from conventional to organic mulch-based cropping system, Applied Soil Ecology, https://doi.org/10.1016/j.apsoil.2020.103639.

Value of the Data

- These data provide useful and multidisciplinary insight of the short-term (3 years) impact of three cropping systems on soil physicochemical and biological characteristics, size and structure of soil microbial community, soil invertebrate biodiversity and habitat provision.
- These data can be useful for researchers, who can use and compare these results with their own.
- These data can be combined with data from other experiments to reveal the impact of cropping systems on soil functions.
- These data provide an in-depth description of: (i) the experimental site, (ii) the crop management, and (iii) the soil properties (taking into account the entire soil profile). These data could be used to validate future studies and to fostering national and/or international collaborations.

Data Description

These data support the research article entitled "Soil functions are affected by transition from conventional to organic mulch-based cropping system", by Massaccesi et al. [1]. The data here reported include:

(1) Cumulated rainfalls and mean air temperatures (ten-day averages) recorded at the experimental station (FieldLab-DSA3, Perugia, Italy) during the experimental period (September 2015 – August 2016) compared to the long-term means over 1950–2015 (Figure 1);

(2) Overview of the durum wheat - processing tomato rotation timeline (Figure 2) and of the experimental plots (Figure 3);

(3) Morphological description of the soil profiles (Table 1) and bulk densities of the Ap1 horizons (Table 2) under integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems.

Table 1

Main descriptive elements obtained from observation of two profiles per each cropping system: integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems, FieldLab-DSA3 (Papiano, Central Italy). For symbols see legend.

Landform: plain; Altitude: 162 m a.s.l.; Parent material: fluvial and lacustrine sediments; Soil: fine, mixed, mesic Typic Haplustept (Soil Survey Staff, 2014).

	Depth cm	Colour[a]	Structure[b]	Roots[c]	Boundary[d]	Other observations
Soil under integrated system (INT)						
Ap1	0-14/15	10YR 4/4	2m sbk	0	cs	Skeleton (by volume): 5%; with a diameter of up to 10 cm
Ap2	14/15-22/27	10YR 4/6	1f-m sbk	0	cw	Skeleton (by volume): 2%; with a diameter < 0.5 cm
Bw1	22/27-40/43	10YR 4/6	1f sbk	0	cs	Skeleton (by volume): < 2%
Bw2	40/43-73/76	10YR 4/6	2f sbk	0	cs	Skeleton (by volume): 5%
BC	73/76-106+	10YR 10/8	1f sbk	v_1	-	Skeleton (by volume): 5%
Soil under traditional organic system (ORG)						
Ap1	0-12	10YR 3/6	3f sbk	1vf,f	cs	Skeleton (by volume): <5%, with a diameter of up to 2 cm
Ap2	12-24	10YR 3/6	2m-c sbk	1vf,f	cw	Skeleton (by volume): 1%; with a diameter < 0.5 cm
Bw1	24-42/44	10YR 4/6	3f-m sbk	1vf,f	cs	Skeleton (by volume): 0%
Bw2	42/44-61/62	10YR 4/4	1m sbk	0	cw	Skeleton (by volume): 0%
BC	61/62-101+	10YR 5/6	1m-c sbk	0	-	Skeleton (by volume): 0%
Soil under innovative organic system (ORG+)						
Oi	1-0					
Ap1	0-6/7	10YR 4/4	3f sbk	3 f,m	cw	Skeleton (by volume): 0%; Signs of compression evidenced by the presence of a superficial crust (0.5 cm) that breaks horizontally.
Ap2	6/7-17/16	10YR 4/4	1m sbk	3 f,m	cw	Skeleton (by volume): < 1%
Ap3	16/17-30	10YR 4/6 10YR 4/3	1m sbk	2 vf,f	cs	Skeleton (by volume): < 1%
Bw1	30-50/51	10YR 5/6 10YR 4/4	2f abk	1 f	cs	Skeleton (by volume): 0%
Bw2	50/51-64/70	10YR 5/8	2f sbk	0	cw	Skeleton (by volume): < 1%
BC	64/70-104+	10YR 5/6	2c sbk	0	-	Skeleton (by volume): 10%; with a diameter < 0.5 cm

[a] moist and crushed, according to the Munsell Soil Color Charts.
[b] 1 = weak, 2 = moderate, 3 = strong; f = fine, m = medium, c = coarse; cr = crumb, abk = angular blocky, sbk = subangular blocky.
[c] 0 = absent, v_1 = very few, 1 = few, 2 = plentiful, 3 = abundant; mi = micro, vf = very fine, f = fine, m = medium, co = coarse.
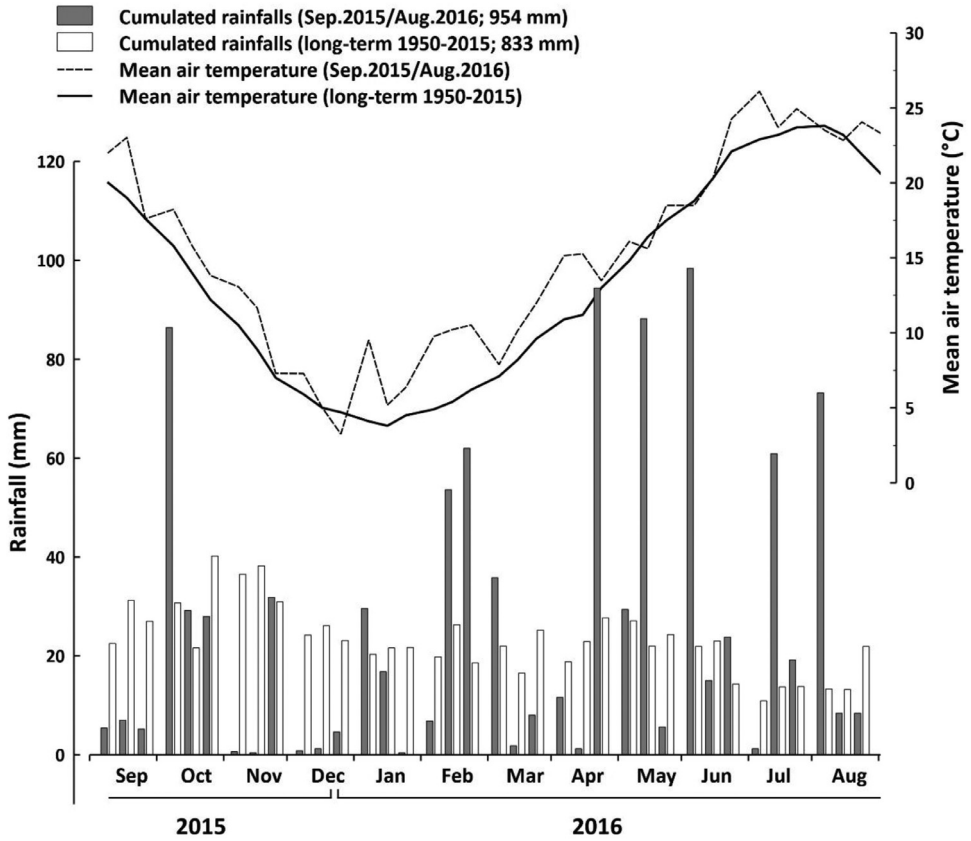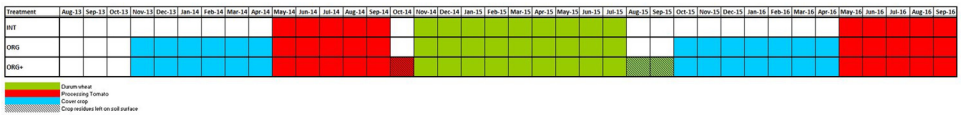[d] a = abrupt, c = clear; w = wavy, s = smooth.

Figure 1.

Figure 2.

Table 2
Bulk density values of Ap1 horizons of the soils under integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems (FieldLab-DSA3, Perugia, Italy). Numbers in parentheses are the standard errors (n=2).

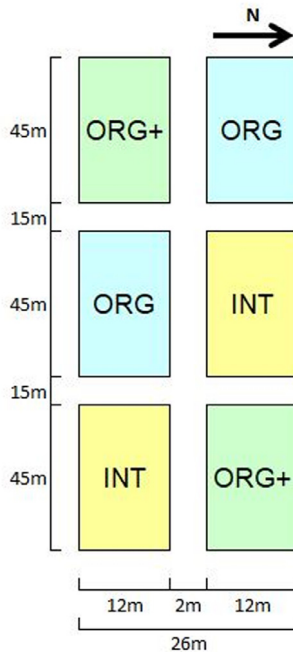|	Bulk density (g cm^{-3})
INT	
Ap1	1.16 (0.01)
ORG	
Ap1	1.17 (0.05)
ORG+	
Ap1	1.44 (0.00)

Figure 3.

(4) Particle size distribution, pH in water (pH$_{H2O}$), available P (P$_{av}$) (Table 3), content of total organic C (TOC), water extractable organic C (WEOC), microbial biomass C (C$_{mic}$), amount of CO$_2$ evolved during basal respiration experiments (Res) (Table 4), content of total phospholipid fatty acids (PLFA) (Table 5) and their nomenclature (Table 6) for the soil horizons under the three cropping systems;

(5) Arthropods collected in May (Table 7) and August 2016 (Table 8) and separated from soil cores using Tullgren funnels and predatory invertebrates collected in August 2016 with Pitfall traps (Table 9), respectively for the three different cropping systems.

Experimental Design, Materials, and Methods

Description of the experimental site and crop management

The data were collected in the year 2015/2016 in the experimental station of the Department of Agricultural, Food and Environmental Sciences of the University of Perugia (FieldLab-DSA3; 42°57' N, 12°22' E), located in Papiano (Perugia, Central Italy). The climatic data of the area were calculated from 65 years (1950 - 2015 series) of consecutive records collected by a meteorological station placed inside FieldLab-DSA3 (Figure 1). The mean annual air temperature (MAAT) of the site is 13.3 °C, while the mean annual precipitation (MAP) is 833 mm (most rainfall events during autumn and winter, and a dry summer) (Figure 1).

A crop rotation of processing tomato (*Solanum lycopersicum* L. cultivar *PS1296*) and durum wheat (*Triticum durum* Desf. cultivar *Dylan*) was established during spring 2013, starting with durum wheat (Figure 2). The rotation was applied to three different cropping systems: the INT system, which consisted in an integrated management with no cover crop and conventional tillage technique; the ORG system, which consisted in a traditional organic management with

Table 3

Particle size distribution (without cement dissolution), pH in water (pH$_{H2O}$) and available P (P$_{av}$) of the soils under integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems (FieldLab-DSA3, Perugia, Italy). Numbers in parentheses are the standard errors (n=2).

	Sand %	Silt	Clay mg kg^{-1}	pH$_{H2O}$	P$_{av}$
INT					
Ap1	24.2(2.2)	42.8(1.7)	33.0(0.6)	7.9(0.1)	40.9(0.8)
Ap2	26.1(0.9)	41.4(1.0)	32.6(0.0)	7.8(0.0)	31.9(4.1)
Bw1	23.8(2.3)	43.6(2.0)	32.6(0.3)	7.8(0.1)	26.9(3.5)
Bw2	21.8(0.6)	45.2(0.0)	33.0(0.6)	7.9(0.0)	14.7(2.1)
BC	25.3(6.6)	43.9(4.9)	30.8(1.7)	8.0(0.0)	5.8(0.4)
ORG					
Ap1	23.3(1.6)	43.3(1.3)	33.4(1.6)	7.8(0.1)	34.8(16.3)
Ap2	24.4(0.2)	42.3(2.8)	33.4(0.2)	7.9(0.0)	25.9(6.1)
Bw1	21.4(1.8)	42.8(1.2)	35.7(0.6)	7.9(0.1)	17.7(1.2)
Bw2	27.6(7.3)	46.5(3.1)	25.9(7.3)	7.8(0.1)	17.0(2.5)
BC	26.8(8.3)	47.2(1.1)	26.1(9.4)	8.0(0.1)	1.5(0.3)
ORG+					
Ap1	26.5(6.3)	44.3(2.7)	29.2(3.6)	7.6(0.1)	36.3(1.8)
Ap2	24.7(6.1)	44.4(1.4)	30.9(4.6)	7.9(0.0)	21.2(2.3)
Ap3	25.3(4.9)	44.4(0.7)	30.4(4.1)	8.0(0.1)	20.8(0.6)
Bw1	23.7(6.0)	45.2(2.0)	31.0(4.0)	8.0(0.0)	17.9(3.3)
Bw2	23.0(4.6)	47.8(2.1)	29.2(2.6)	8.0(0.0)	15.1(3.0)
BC	24.5(1.3)	50.0(3.0)	25.5(1.3)	8.1(0.0)	2.8(3.1)

Table 4

Content of total organic C (TOC), water extractable organic C (WEOC) and microbial biomass C (C$_{mic}$), and amount of CO$_2$ evolved during basal respiration experiments (Res) for the soils under integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems (FieldLab-DSA3, Perugia, Italy). Numbers in parentheses are the standard errors (n=2).

	TOC g kg^{-1}	WEOC mg kg^{-1}	C$_{mic}$ mg kg^{-1}	Res mg kg^{-1}
INT				
Ap1	8.2(0.4)	144.8(11.1)	68.73(28.8)	787.8(480.7)
Ap2	9.1(0.5)	23.3(0.3)	78.84(22.5)	305.0(3.1)
Bw1	7.5(0.2)	21.9(0.7)	95.02(46.2)	248.7(35.8)
Bw2	6.9(0.5)	18.9(0.8)	87.47(23.7)	200.1(39.7)
BC	4.2(0.2)	15.3(2.1)	59.01(16.3)	153.6(34.4)
ORG				
Ap1	8.8(0.2)	144.1(3.8)	141.98(26.4)	578.6(9.8)
Ap2	8.7(0.5)	24.0(0.3)	81.07(54.5)	488.1(32.6)
Bw1	8.1(0.4)	20.0(0.4)	119.9(45.8)	463.0(131.3)
Bw2	6.6(0.2)	18.8(0.9)	100.1(33.4)	375.5(65.0)
BC	5.2(0.6)	16.7(2.4)	66.63(1.5)	252.7(14.1)
ORG+				
Ap1	11.5(0.9)	150.0(2.6)	164.1(37.1)	777.8(164.7)
Ap2	8.1(0.6)	24.1(1.1)	115.98(5.9)	345.4(11.8)
Ap3	7.6(0.2)	19.3(1.2)	122.14(13.3)	266.2(72.2)
Bw1	8.2(0.4)	24.0(1.5)	121.86(27.2)	385.5(90.5)
Bw2	6.7(0.2)	28.8(6.9)	78.73(1.6)	320.6(62.3)
BC	5.1(0.3)	22.5(2.3)	55.78(5.5)	273.7(66.8)

cover crop and conventional tillage; the ORG+ system, which consisted in an innovative organic management with cover crop mulch-based no-tillage technique (ORG+). Two blocks, each consisting of three plots of 540 m^2 each were arranged (Figure 3). The samplings were conducted in 2016.

Processing tomato was preceded by an autumn-sown mixture of barley (25% of its full sowing rate) and field pea (75% of its full sowing rate) in ORG and ORG+ and by bare soil in INT. At

Table 5
Content of total phospholipid fatty acids (PLFA) and of specific PLFA used to quantify the relative abundance of the individual cell types comprising the soil microbial community under integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems (FieldLab-DSA3, Perugia, Italy). Numbers in parentheses are the standard errors (n=2).

	Total PLFAs (nmol C g^{-1})	Bacterial PLFA (nmol C g^{-1})	Gram-positive bacteria PLFA (nmol C g^{-1})	Gram-negative bacteria PLFA (nmol C g^{-1})	Fungal PLFA (nmol C g^{-1})	AMF PLFA (nmol C g^{-1})	Actinomycetes PLFA (nmol C g^{-1})	Protozoa PLFA (nmol C g^{-1})
INT								
Ap1	14.82(4.65)	6.55(0.12)	3.19(0.05)	3.36(0.08)	0.08(0.08)	0.72(0.18)	6.09(0.78)	0.14(0.15)
Ap2	21.13(3.14)	8.54(3.37)	2.43(0.08)	5.89(3.21)	0.22(0.22)	0.61(0.00)	8.86(0.90)	0.00(0.00)
Bw1	13.05(0.88)	5.30(0.53)	1.79(0.22)	3.51(0.31)	0.63(0.63)	0.35(0.03)	4.65(3.22)	0.26(0.43)
Bw2	15.72(0.82)	4.60(0.66)	1.77(0.21)	2.83(0.44)	0.00(0.00)	0.26(0.02)	9.44(0.15)	0.00(0.00)
BC	12.49(0.47)	3.24(0.93)	0.52(0.21)	2.72(0.72)	0.00(0.00)	0.06(0.00)	7.97(0.05)	0.03(0.00)
ORG								
Ap1	33.6(2.89)	19.62(4.87)	10.25(1.96)	9.33(2.90)	0.73(0.73)	2.11(0.39)	7.37(0.79)	0.23(0.22)
Ap2	22.77(5.38)	12.21(1.09)	6.03(0.26)	6.08(1.34)	0.41(0.11)	1.76(0.03)	6.10(4.10)	0.02(0.00)
Bw1	23.14(13.55)	13.22(3.53)	4.79(2.30)	8.26(1.19)	0.45(0.45)	1.23(0.33)	5.31(0.80)	0.12(0.20)
Bw2	15.03(3.65)	8.67(1.30)	4.48(0.31)	5.89(1.58)	0.65(0.65)	0.67(0.21)	1.49(0.16)	0.55(0.62)
BC	9.31(5.67)	4.10(0.61)	0.85(0.40)	3.19(0.20)	0.17(0.17)	0.05(0.04)	2.74(1.07)	0.47(0.02)
ORG+								
Ap1	26.91(2.47)	13.85(1.07)	6.35(1.39)	7.38(0.33)	1.05(1.05)	1.88(0.23)	8.56(0.00)	0.00(2.00)
Ap2	26.71(1.55)	11.31(0.18)	5.24(0.32)	6.04(0.49)	0.91(0.89)	0.82(0.06)	10.44(0.50)	0.22(0.08)
Ap3	16.46(5.04)	7.27(2.74)	2.53(0.31)	4.62(2.38)	0.00(0.00)	0.76(0.07)	6.70(0.00)	0.00(1.51)
Bw1	16.04(2.67)	6.98(0.74)	2.95(0.15)	4.02(0.60)	0.00(0.00)	0.65(0.04)	7.23(0.03)	0.04(0.12)
Bw2	17.40(1.13)	6.15(1.68)	2.75(0.45)	3.37(1.22)	0.00(0.00)	0.64(0.12)	8.91(0.00)	0.00(0.45)
BC	7.84(4.52)	3.15(1.15)	0.80(0.02)	2.27(1.14)	0.00(0.00)	0.11(0.01)	3.34(0.03)	0.06(4.06)

Table 6

PLFA nomenclature

Microbial group	PLFA	References
Gram-positive bacteria	i15:0, a15:0, i16:0, i17:0, a17:0	Federle, [8]; Frostegård et al., [9]; Fierer et al., [10]; Massacesi et al., [11].
Gram-negative bacteria	16:1, cy17:0, 17:1ω9c, 18:1ω7	Federle, [8]; Frostegård et al., [9]; Fierer et al., [10]; Massacesi et al., [11].
Saprophytic fungi	18:2ω6	Federle, [8].
Arbuscular mycorrhizal fungi (AMF)	16:1ω5	De Deyn et al., [12].
Actinomycetes	10Me17:0, 10Me18:0	Kroppenstedt, [13]; De Deyn et al., [12].
Protozoa	20:2	Fierer et al., [10].

Table 7

Arthropods collected in May 2016 with Tullgren funnels at three different soil horizons (Ap: 0-10 cm depth, Bw1: 30-40 cm and Bw2: 51-61 cm depth), respectively from integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems. Shannon diversity indexes have been calculated excluding unidentified invertebrates.

Class	Order	Family	Genus / Species	Ap			Bw1			Bw2		
				INT	ORG	ORG+	INT	ORG	ORG+	INT	ORG	ORG+
Arachnida	Oribatida	Oribatidae		-	1	4	-	-	-	-	-	-
Entognatha	Diplura	Parajapygidae		-	-	-	-	1	1	-	-	-
Insecta	Coleoptera	Staphylinidae	*Anotylus inustus*	-	-	1	-	-	-	-	-	-
Insecta	Coleoptera	Staphylinidae	*Platystethus nitens*	-	2	-	-	-	-	-	-	-
Insecta	Coleoptera	Elateridae	*Agriotes litigiosus*	-	-	1	-	-	-	-	-	-
Insecta	Coleoptera			-	3	1	-	-	-	-	-	-
Insecta	Diptera	Agromyzidae		-	-	-	-	1	-	-	-	-
Insecta	Diptera	Cecidomyiidae		-	1	-	-	-	-	-	-	-
Insecta	Diptera	Sciaridae	*Corynoptera* sp.	-	-	-	1	-	1	-	-	-
Insecta	Diptera	Sciaridae	*Lycoriella* sp.	-	1	-	1	2	-	-	-	-
Insecta	Hymenoptera	Formicidae		1	1	2	-	-	-	-	-	-
Insecta	Hymenoptera			-	1	-	-	-	-	-	-	-
unidentified				-	1	3	-	-	-	1	2	2
Shannon Index				1.83	1.43	0.69	1.04	0.69	0	0	0	

Table 8

Arthropods collected in August 2016 with Tullgren funnels from soils (0-10 cm depth), respectively from integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems. Shannon diversity indexes have been calculated excluding unidentified invertebrates.

Class	Order	Family	Subfamily / Genus / Species	INT	ORG	ORG+
Arachnida	Sarcoptiformes	Achipteriidae	*Anachipteria* sp.	-	-	2
Arachnida	Sarcoptiformes/Oribatida	Oribatidae		-	-	4
Arachnida	Sarcoptiformes/Oribatida			8	1	5
Chilopoda	Geophilomorpha	Geophilidae	*Geophilus flavus*	-	-	1
Chilopoda	Geophilomorpha	Linotaeniidae	*Strigamia* sp.	-	-	1
Entognatha	Poduromorpha	Hypogastruridae	*Ceratophysella* sp.	1	-	5
Insecta	Homoptera	Cicadellidae		1	-	-
Insecta	Coleoptera	Carabidae	*Elaphropus* sp.	-	1	-
Insecta	Coleoptera	Carabidae	*Pterostichus* sp.	-	2	-
Insecta	Coleoptera	Chrysomelidae	*Epitrix hirtipennis*	1	-	-
Insecta	Coleoptera	Scarabaeidae	*Pleurophorus caesus*	-	1	2
Insecta	Coleoptera	Scarabaeidae		1	-	-
Insecta	Diptera	Sciaridae	*Bradysia tilicola*	5	1	-
Insecta	Diptera	Sciaridae	*Corynoptera* sp.	-	-	1
Hymenoptera	Cynipoidea	Figitidae	*Eucoilinae*	1	-	-
unidentified				-	5	2
Shannon Index				1.52	1.56	1.88

Table 9

Predatory invertebrates collected in August 2016 with Pitfall traps, respectively from integrated (INT), traditional organic (ORG) and innovative organic (ORG+) cropping systems.

Group	Species	INT	ORG	ORG+
Ground beetles	*Bembidion quadrimaculatum*	1	7	1
	Harpalus distinguendus	1	1	1
	Harpalus (Pseudoophonus) rufipes	7	6	50
	Microlestes minutulus	-	1	-
	Poecilus cupreus	-	2	4
Spiders	unidentified	8	24	62

mid-April, in the ORG system, the cover crop was incorporated into the soil through a rotary hoe tiller, while in the ORG+ system, a roller crimper was used and the cover crop biomass was left on the soil as dead mulch.

At the end of May, processing tomato was transplanted after a rotary tiller operation at ∼20 cm depth (INT and ORG) or after a shallow strip-tillage operation (ORG+) performed (at 10-20 cm depth) using a prototype no PTO-powered strip tiller (CMA S.r.l., Italy). All plots were N fertilized by means of fertigation (details on scheduling and methods in Farneselli et al. [2] and Massaccesi et al. [1]).

Soil sampling for physical, chemical and microbial analyses

The soil sampling was conducted on May 9th, 2016, before the processing tomato transplanting operations. A soil profile was dug within each plot to a depth of at least 90 cm and its morphology described according to Schoeneberger et al. [3] (Table 1). For each profile, about 1 kg of soil from every mineral horizon was sampled and carried in a portable refrigerator to the laboratory.

For details on methodologies used for chemical and biological soil properties see [1].

Soil invertebrate biodiversity

Soil samples for evaluation of invertebrate biodiversity were taken from the differently managed plots (INT, ORG and ORG+) on May 9th, 2016 (before processing tomato transplanting) and on August 12th, 2016 (before the harvesting operation of processing tomato). In May, one core of 1 dm^3 (10 cm Ø) was taken from each of the three horizons (Ap: 0-10 cm depth, Bw1: 30-40 cm and Bw2: 51-61) of each plot. The samples were put together to form one composite sample for each of the three systems [4]. Similarly, in August two soil cores were collected from the Ap horizons (0-10 cm depth) of all treatments. Each soil core was subsequently placed inside a heated Tullgren funnel and the invertebrates were isolated as specified in Massaccesi et al. [1]. Total DNA purification, PCR amplification using Foelmer's primer [5] and Sanger sequencing were conducted as specified in [1] and elsewhere [6,7]. For identification, consensus sequences were compared to sequences deposited to GenBank using BLAST. The identified individuals at the species, genus, family or order level are reported in table 7 and table 8.

Also, four pitfall traps (each filled with 150 ml of 70% EtOH) per each of the 6 plots were positioned on August 13th 2016 and left in place for 24h. Collected carabid beetles were identified using DNA barcoding as described above (Table 9) and dissected for molecular analysis of gut content [1].

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships which have, or could be perceived to have, influenced the work reported in this article.

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References

[1] L. Massaccesi, G. Rondoni, G. Tosti, E. Conti, M. Guiducci, A. Agnelli, Soil functions are affected by transition from conventional to organic mulch-based cropping system, Appl. Soil Ecol., https://doi.org/10.1016/j.apsoil.2020.103639.

[2] M. Farneselli, G. Tosti, A. Onofri, P. Benincasa, M. Guiducci, E. Pannacci, F. Tei, Effects of N sources and management strategies on crop growth, yield and potential N leaching in processing tomato, Eur. J. Agron. 98 (2018) 46–54, doi:10.1016/j.eja.2018.04.006.

[3] P.J. Schoeneberger, D.A. Wysocki, E.C. Benham, Soil Survey Staff, Field book for describing and sampling soils, Version 3.0, Natural Resources Conservation Service, National Soil Survey Center, Lincoln, NE, 2012.

[4] M.A. Tsiafouli, E. Thébault, S.P. Sgardelis, P.C. Ruiter, W.H. Putten, K. Birkhofer, L. Hemerik, F.T. Vries, R.D. Bardget, M.V. Brady, L. Bjornlund, H.B. Jørgensen, S. Christensen, T.D. Hertefeldt, S. Hotes, W. Gera Hol, J. Frouz, M. Liiri, S.R. Mortimer, H. Setälä, J. Tzanopoulos, K. Uteseny, V. Pižl, J. Stary, V. Wolters, K. Hedlund, Intensive agriculture reduces soil biodiversity across Europe, Global Change Biol 21 (2015) 973–985, doi:10.1111/gcb.12752.

[5] O. Folmer, M. Black, W. Hoeh, R. Lutz, R. Vrijenhoek, R. DNA primers for amplification of mitochondrial cytochrome c oxidase subunit I from diverse metazoan invertebrates, Mol. Mar. Biol. Biotech. 3 (1994) 294–299.

[6] G. Rondoni, K.J. Athey, J.D. Harwood, E. Conti, C. Ricci, J.J. Obrycki, Development and application of molecular gut-content analysis to detect aphid and coccinellid predation by Harmonia axyridis (Coleoptera: Coccinellidae) in Italy, Insect Sci 22 (2015) 719–730, doi:10.1111/1744-7917.12165.

[7] G. Rondoni, S. Fenjan, V. Bertoldi, F. Ielo, K. Djelouah, C. Moretti, R. Buonaurio, C. Ricci, E. Conti, Molecular detection of field predation among larvae of two ladybird beetles is partially predicted from laboratory experiments, Sci. Rep. 8 (2018) 2594, doi:10.1038/s41598-018-20830-2.

[8] T.W. Federle, Microbial distribution in soild new techniques, in: F. Megusar, M. Gantar (Eds.), Perspectives in Microbial Ecology, Slovene Society for Microbiology, Ljubljana, 1986, pp. 493–498.

[9] Å. Frostegård, E. Bååth, A. Tunlid, Shifts in the structure of soil microbial communities in limed forests as revealed by phospholipid fatty acid analysis, Soil Biol. Bioch. 25 (1993) 723–730.

[10] N. Fierer, J.P. Schimel, P.A. Holden, Variation in microbial community composition through two soil depth profiles, Soil Biol. Bioch. 35 (2003) 167–176.

[11] L. Massaccesi, A. Agnelli, R.D. Bardgett, N. Ostle, A. Wilby, K.H. Orwin, Impact of plant species evenness, dominant species identity and spatial arrangement on the structure and functioning of soil microbial communities in a model grassland, Oecologia 177 (2015) 747–759.

[12] G. De Deyn, H. Quirk, R. Bardgett, Plant species richness, identity and productivity differentially influence key groups of microbes in grassland soils of contrasting fertility, Biol. Lett. 7 (2011) 75–78.

[13] R.M. Kroppenstedt, Fatty acid and menaquinone analysis of actinomycetes and related organisms, in: M. Goodfellow, D.E. Minnikin (Eds.), Chemical Methods in Bacterial Systematics, Society for Applied Bacteriology (Technical Series No. 20), Academic Press, London, 1985, pp. 173–199.