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Organic farming fosters agroecosystem functioning in Argentinian temperate soils: Evidence from litter decomposition and soil fauna

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ABSTRACT

Benefits of organic farming on soil fauna have been widely observed and this has led to consider organic farming as a potential approach to reduce the environmental impact of conventional agriculture. However, there is still little evidence from field conditions about direct benefits of organic agriculture on soil ecosystem functioning. Hence, the aims of this study were to compare the effect of organic farming versus conventional farming on litter decomposition and to study how this process is affected by soil meso- and macrofauna abundances. Systems studied were: (1) organic farming with conventional tillage (ORG), (2) conventional farming with conventional tillage (CT), (3) conventional farming under no-tillage (NT), and (4) natural grassland as control system (GR). Decomposition was determined under field conditions by measuring weight loss in litterbags. Soil meso- and macrofauna contribution on decomposition was evaluated both by different mesh sizes and by assessing their abundances in the soil. Litter decomposition was always significantly higher after 9 and 12 months in ORG than in CT and NT (from 2 to 5 times in average), regardless decomposer community composition and litter type. Besides, mesofauna, macrofauna and earthworm abundances were significantly higher in ORG than in NT and CT (from 1.6 to 3.8, 1.7 to 2.3 and 16 to 25 times in average, respectively for each group). These results are especially relevant firstly because the positive effect of ORG in a key soil process has been proved under field conditions, being the first direct evidence that organic farming enhances the decomposition process. And secondly because the extensive organic system analyzed here did not include several practices which have been recognized as particularly positive for soil biota (e.g. manure use, low tillage intensity and high crop diversity). So, this research suggests that even when those practices are not applied, the non-use of agrochemicals is enough to produce positive changes in soil fauna and so in decomposition dynamics. Therefore, the adoption of organic system in an extensive way can also be suggested to farmers in order to improve ecosystem functioning and consequently to achieve better soil conditions for crop production.

1. Introduction

In the last decades, the spread of croplands has been associated with an unprecedented level of environmental degradation (Barrios, 2007; Foley et al., 2011). This situation has become noticeable in Argentina (e.g. Cantú et al., 2001; Bedano et al., 2006; Bedano and Ruf, 2007; Domínguez et al., 2010), where there has been a marked process of “agriculturization” characterized by a strong and continuous increase in the land area dedicated to crop production. Moreover, the adoption of no-till agriculture, covering in 2011 a 78.5% of the total cultivated area, has been accompanied by an impressive expansion of the genetically modified soybean tolerant to glyphosate, reducing the area devoted to other crops, pastures, and forests (Manuel-Navarrete et al., 2007; AAPRESID, 2012). The agriculturization process has had social and environmental effects. Small and medium farmers are disappearing, and as a consequence, traditional knowledge, rural culture, particular ways of living, and production schemes are also lost (Manuel-Navarrete et al., 2007). A decrease of fauna abundances and diversity has been recorded (Bedano et al., 2006; Bedano and Ruf, 2007; Arolfo et al., 2010; Domínguez et al., 2010), together with soil physical and chemical degradation (Cantú and Becker, 1999).

The situation previously outlined has posed great challenges, such as the need to find alternative farming systems so as to avoid negative social consequences and to allow soil biodiversity conservation. Organic farming has been proposed as one of such

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alternative farming system (IFOAM, 2012). Given the vast land areas cultivated in Argentina, this system is commonly practiced in an extensive way. Thus, there are several similarities between organic farming and conventional farming; for example, in both cases farms are large-scale, with low crop rotation and low crop diversity. Although large-scale organic farming may have fewer social interest than agroecological small holder farming systems, it may have significant consequences for the reduction of environmental pollution and the conservation of soil biodiversity and, therefore, for the maintenance of soil ecosystem functioning (Barrios, 2007). However, direct benefits of organic farming to key soil processes, such as plant litter decomposition, and their relation to soil fauna communities, still remain unclear. There is particularly little evidence on contexts of organic farming with high tillage intensity and low crop diversity.

Litter decomposition is one of the most important ecosystem processes performed by soil organisms as it represents the catabolic complement of photosynthesis (Barrios, 2007). It is defined as the ecosystem process that converts plant material into easily accessible inorganic compounds used by soil heterotrophs and plants (Cebrian, 1999; Wilkinson, 2006). Under given climatic conditions, decomposition is governed by several factors, such as litter quality, litter placement and soil organisms. Litter quality affects decomposition in terms of both residue degradability and feeding preferences of the decomposer community for residue originated in situ, an effect that has been called ‘home field advantage’ (Ayres et al., 2009). Buried litter decomposes faster than surface litter, mainly because when buried it maintains higher water content and supports greater densities of microflora and fauna (Beare et al., 1992). Soil organisms also control decomposition, with soil fauna mainly feeding on and digesting the detritus, and with fungi and bacteria degrading and metabolizing litter components within a complex food web (Cotrufo et al., 2009). Through predation soil fauna also controls the abundance and diversity of the microbial community which is the real ‘decomposition engine’ (Cotrufo et al., 2009). Indeed, several studies have documented the importance of soil mesofauna and macrofauna for the decomposition process, and have also informed about higher decomposition rates when soil macrofauna is involved in the decomposition process (e.g. Beare et al., 1997; Ke et al., 2005; Milton and Kaspari, 2007).

Benefits of organic farming for soil biota development have been frequently reported (e.g. Bettiol et al., 2002; Birkhofer et al., 2008; Osler et al., 2008), however, studies comparing under field conditions decomposition dynamics between organic agriculture and conventional agriculture, including tillage variants, are very scarce. Most of the research has compared conventional farming (i.e. with agrochemical use) with or without tillage (e.g. Beare et al., 1997) and also conventional farming with organic farming, both using conventional tillage (e.g. Fließbach et al., 2000). Studies which deal with the contribution of different components of the soil fauna to the decomposition process are also scarce, especially in agricultural systems.

The aims of the present research were to analyze the effect of organic farming versus conventional farming (under both conventional tillage and no-tillage) on the litter decomposition process and to analyze how this process is affected by soil meso and macrofauna abundances. Our general hypothesis is that the litter decomposition process would be driven by the interaction of agricultural management, decomposer fauna community, litter type and time of field exposure. Specifically, we hypothesize that (1) organic management would enhance higher litter decomposition than conventional management systems; (2) management systems involving conventional tillage would enhance higher decomposition rate than no-tillage management; (3) higher decomposition would be positively related to higher soil meso and macrofauna abundances; (4) the contribution of macrofauna would increase decomposition; and (5) the local litter in each field would decompose more rapidly than an allochthonous litter.

2. Materials and methods

2.1. Study area

The experiment was conducted during 2009 and 2010 in the south of Córdoba province, Argentina (33°17′ and 32°21′ S; 63°54′ and 63°46′ W). Soil is a loamy, illitic, thermic Typic Haplustoll (Soil Survey Staff, 2010). The climate is sub humid temperate with a dry season in winter; mean annual rainfall is 840 mm and mean annual temperature is 17 °C. However, annual rainfall in both sampled years was slightly lower than the mean, being 638 mm in 2009 and 734 mm in 2010. To control for variation in climate and soil characteristics, eight sites located at a maximum distance of 10 km from one another were selected.

2.2. Characterization of farming practices

The following management systems were studied: (1) organic farming with conventional tillage and occasional grazing (ORG), (2) conventional farming with agrochemical use and conventional tillage (CT), and (3) conventional farming with agrochemical use and no-tillage (NT). The three management systems were represented by two fields (replications), each of at least 25 ha in area. Detailed management practices of agricultural fields are presented in Table 1. As we used non-experimental plots, there were differences in crop rotation because crop history depended on farmers decisions. Non-experimental plots were chosen to study real agricultural systems of the region. In addition, two natural grasslands (GR) of about 0.5 ha were included in the study as reference sites. These natural sites have been undisturbed and covered with natural pastures for the last 50 years. The plant community belongs to the Pampean phytogeographic province (Cabrera, 1976). The community was dominated by *Stipa* sp and also species belonging to the genera *Brassica*, *Oxalis*, *Eragrostis*, *Poa*, *Panicum*, and *Rapistrum* were present. Plant cover was 100% and the litter layer was approximately 1 cm thick. These sites were not managed; they had only had occasional grazing.

2.3. Litter decomposition measurement

Litter decomposition was determined under field conditions by measuring weight loss in vegetal litter inside nylon mesh bags. This technique has been critically evaluated (Prescott, 2005), mainly because the confining of litter generates different field conditions from the natural ones and because it tends to underestimate decomposition (Coleman et al., 2004). Sometimes, decomposition may be overestimated if large mesh sizes are used to evaluate fauna contribution (Graca et al., 2005). However, the scientific community agrees that this methodology is simple and useful especially for comparative studies, where methodological errors are similar (e.g. Graca et al., 2005; OECD, 2006; Berg and McClaugherty, 2008). Also, Lavelle et al. (2006) recognized that the faunal contribution in nutrient cycling must be assessed by litterbag decomposition studies.

In this research, two litter types were used to fill the litterbags: the local senescent litter of each field and a control litter (*Sorghum halepensis* in all fields). Since one of the major effects of crop type on the decomposition process is the chemical quality of supplied residues, the inclusion of a control litter helps to preclude to certain extent the possible effect of different crop rotations between the evaluated sites. It also enables us to evaluate whether or not decomposer community prefers litter originated in situ. All litter types were air-dried at 30 °C for 72 h before litterbag construction.

Table 1
Farming practices conducted in the agricultural fields.

	Organic farming		Conventional farming with conventional tillage		Conventional farming with no tillage	
	Field 1	Field 2	Field 1	Field 2	Field 1	Field 2
Tillage	Conventional	Conventional	Conventional	Conventional	No	No
Crop	Corn	Sunflower	Soybean	Soybean	Corn	Corn
Crops in the previous 5 years	O–C/C–Sg/O–Sf/Sg/O–Sy	O–Sf/O–Sg/C/Sf/Sy/Sf	C/C/Sy/Sy/Sy	C/C/Sy/Sy/Sy	Sy/Sy/W–Sy/C/Sy	Sy/C/Sy/C/W–Sy
Chemical fertilizers	–	–	–	–	Sulfur	Urea, ammonium nitrate
Herbicides	–	–	Glyphosate	Glyphosate	Glyphosate, atrazine, acetochlor, nicosulfuron	Glyphosate, atrazine, metolachlor
Insecticides	–	*Bacillus thuringiensis*	–	–	Lambdacyalothrine	–
Weed control	Mechanical	Mechanical	Mechanical and chemical	Mechanical and chemical	Chemical	Chemical
Grazing	Yes	No	Yes	No	No	No

C, corn; O, oat; Sy, soybean; Sg, sorghum; Sf, sunflower; W, wheat.

The mesh size treatment comprised litterbags of 2 mm mesh size, which allowed access to microflora, microfauna and mesofauna; and litterbags of 10 mm mesh size, which also allowed access to macrofauna.

Within each field, five replicates per treatment were established, resulting in a total of 480 litter bags (four systems × two fields per system × two mesh sizes × two litter types × five replicates × three collection dates). Litterbags, each containing 20 g of dry weight plant material, were placed in the field in July 2009 (winter season) by securing them with pegs on the soil surface. In February 2010 (summer season), in fields subjected to tillage (organic farming and conventional farming with tillage), litterbags were buried into the soil to simulate the same placement as that of crop residues.

Five replicates were collected on each sampling date: after 4 months (November 2009), 9 months (April 2010) and one year (July 2010) of field exposure. Litterbags were carefully placed individually into plastic bags to avoid litter loss and immediately transported to the laboratory. Litter was oven-dried at 60 °C for 48 h and weighed; then an aliquot of the remaining litter in each litterbag was burned at 800 °C for 1 h to determine ash free dry weight and correct the percentage of remaining litter by deducting the presence of mineral soil. Litter decomposition was estimated as the percentage of ash free dry weight remaining over time.

2.4. Soil fauna sampling

Relationship between litter decomposition and soil fauna not only indirectly by means of selective exclusion through litterbags mesh size, but also directly was determined. Soil meso- and macrofauna densities were assessed in early autumn 2010, simultaneously on the second date of litterbag collection. Considering climate conditions of the region, this date was selected for fauna sampling because it matches with the most suitable soil conditions for fauna development, with temperate soil temperatures and with the highest rainfalls recently recorded. Sampling was done adjacent to each of the five replicates collected. Mesofauna was sampled by extracting five undisturbed soil cores (5 cm diameter and 10 cm depth) followed by a 10-day Berlese funnel extraction. Macrofauna was sampled by digging five soil monoliths of 25 cm × 25 cm × 10 cm that were transported to the laboratory and hand sorted to extract the total macro-invertebrates present. Collembola (springtails) and earthworm densities were also evaluated, both because of their relevance on the decomposition process (Filser et al., 2002; Lavelle et al., 2006) and because they are easy to separately collect and identify as well. Fauna density is expressed as the number of individuals/m^2.

2.5. Statistical analyses

All statistical analyses were performed using InfoStat software (Di Rienzo et al., 2012), as it is a friendly interpreter of R software.

2.5.1. Litter decomposition

To assess the overall effects of all the factors evaluated on the percentage of remaining ash free dry weight, a number of general linear mixed models were performed and Akaike's information criterion was used to determine the best predictive model. In the best-fit model, the fixed factors were: agricultural management system, decomposer fauna, litter type and time of field exposure. The random factors were: the field (replicate of the management system) and the litterbags collected on each sampling date for each treatment (replicate in each field). Error variance structure was modelled using management system, fauna and time as grouping criteria and Var (Ident) of R's *nlme* library as variance function. A posteriori tests were performed by the DGC test (Di Rienzo et al., 2002).

2.5.2. Soil mesofauna and macrofauna

A generalized linear mixed model was performed to assess the effect of management systems on fauna abundances. According to the distribution of abundance data, Poisson error distribution and log link function were used. The management system was the fixed factor assessed, while the field was used as random parameter. A posteriori tests were performed by the DGC test (Di Rienzo et al., 2002).

3. Results

3.1. Litter decomposition

The decomposition process was driven by agricultural management system, decomposer fauna, litter type and time of field exposure (Table 2). These factors did not act separately but in a complex interaction with one another, as it is shown by three of the four triple interactions which were statistically significant in the model (Table 2). The agricultural management system significantly interacted with decomposer fauna, litter type and time of field exposure.

3.1.1. Effect of management system

On the first collection date, decomposition rates did not differ between both conventional management systems (NT and CT), regardless of decomposer fauna and litter type. The decomposition

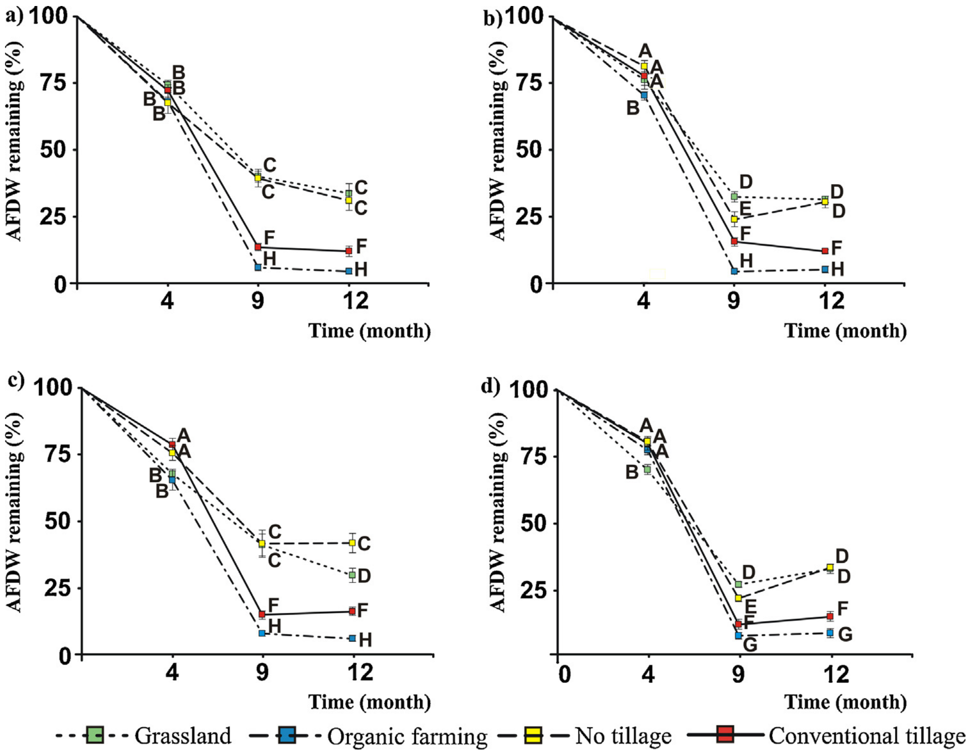

Fig. 1. Residue decomposition measured as the remaining percentage of ash free dry weight (AFDW). (a) Original residue with macrofauna; (b) original residue without macrofauna; (c) control residue with macrofauna and (d) control residue without macrofauna. Means with the same letter are not significantly different ($p < 0.05$) (valid for all possible comparisons).

rate of the original litter on the first date was from 7.5% to 13.5% higher in ORG than in the other management systems, when macrofauna was not included in the decomposer community (Fig. 1b, $p < 0.05$). Instead, the decomposition rate of the control litter on the first date was from 12% to 15% higher in ORG and GR than in both conventional systems, when macrofauna was comprised in the decomposer fauna (Fig. 1c, $p < 0.05$). On the second and third collection dates, decomposition rates were always higher (Fig. 1a–d) in ORG than in CT (from a 34% to 84%) and in CT higher than in NT and GR systems. Also, when macrofauna was comprised in the decomposer community, the decomposition rate of the control litter was about 30% higher in GR than in NT in the third collection date (Fig. 1c, $p < 0.05$). Conversely, when macrofauna was excluded of the decomposer community, decomposition rate was from 19% to 26% higher in NT than in GR on the second time of collection (Fig. 1b and d). Except for the above cases, decomposition rates in NT and GR were similar.

Table 2
General linear mixed model showing the overall effects of management system, decomposer fauna, residue type and time of field exposure on residue decomposition (measured as percentage of ash free dry weight remaining).

Term	df	*F*-value	*p*-Value
Management (*M*)	3	111.51	0.0003
Fauna (*F*)	1	41.27	<0.0001
Residue (*R*)	1	4.8	0.0292
Time (*T*)	2	3367.1	<0.0001
$M \times F$	3	5.57	0.001
$M \times R$	3	10.23	<0.0001
$M \times T$	6	46.84	<0.0001
$R \times F$	1	0.09	0.7591
$R \times T$	2	2.05	0.1309
$F \times T$	2	21.4	<0.0001
$M \times R \times F$	3	5.08	0.0019
$M \times R \times T$	6	2.15	0.0474
$M \times F \times T$	6	4.5	0.0002
$\mathrm{R} \times F \times T$	2	0.77	0.4660
$M \times R \times F \times T$	6	0.71	0.6437

3.1.2. *Effect of decomposer fauna*

The effect of macrofauna on decomposition was measured through mesh size, and it was different according to management system, litter type and time of field exposure. On the first collection date, the contribution of macrofauna significantly increased decomposition rate of the original litter in GR, NT and CT (from 3% to 18%), whereas the decomposition in ORG was similar regardless of the decomposer fauna (Fig. 1a and b, $p < 0.05$). In the case of the control litter, the contribution of macrofauna significantly increased decomposition rate in ORG (15%), but there were no differences in the other systems arising from the composition of the decomposer community (Fig. 1c and d, $p < 0.05$). On the second date, the decomposition rate was 25% higher when macrofauna was not involved in the decomposer fauna in GR and 42% in NT, regardless of litter type (Fig. 1a–d, $p < 0.05$). On the third date, the original litter decomposition in NT and in GR was also higher without the inclusion of macrofauna. Instead, control litter decomposition on the third date was similar, independent of the composition of the decomposer fauna, except in the case of no-tillage. Furthermore, the decomposition rate of control litter in ORG was always higher – 17% on average – when the macrofauna was comprised in the decomposer community, regardless of collection date (Fig. 1a–d, $p < 0.05$).

3.1.3. *Effect of litter type*

When the macrofauna was included in the decomposer community, the decomposition rate of the original litter was from 8.4% to 10.8% higher than that of the control in both conventional systems on the first date (Fig. 1a and c, $p < 0.05$). Instead, the decomposition of the control litter in GR was 11.8% higher than the decomposition of the original on the third date (Fig. 1a and c, $p < 0.05$). When the macrofauna was excluded of the decomposer community, on the first date the decomposition rate of the control was 9% higher than that of the local litter in GR, but the opposite was observed for ORG system (8%) (Fig. 1b and d, $p < 0.05$). On the second and third dates decomposition rate of control litter in ORG was about 37–38% higher than the decomposition of original (Fig. 1b and d, $p < 0.05$).

3.1.4. Effect of time of field exposure

The litter decomposition was always higher (70% on average) after 9 months of field exposure with regard to the decomposition rate after 4 months of field exposure (Fig. 1, $p < 0.05$). However, minor differences (of about 1.5%) between 9 and 12 months of field exposure were observed (Fig. 1, $p > 0.05$).

3.2. Soil meso- and macrofauna

Abundances in the soil of total mesofauna and macrofauna were always significantly higher in the organic system than in both conventional farming systems (Fig. 2a and c). Collembolans (Fig. 2b) had similar abundances in natural grasslands, organic farming and no-tillage, being significantly less abundant in the conventional tillage. Strikingly, earthworms (Fig. 2d) were absent in the no-tillage system. Otherwise, earthworms were significantly more abundant in the organic farming than in the conventional tillage system.

4. Discussion

Our results support our general hypothesis that the decomposition process would be driven by all the factors analyzed: agricultural management system, decomposer fauna, litter type and time of field exposure. These factors led the decomposition process by means of complex interactions with one another. This result is consistent with previous reports that emphasize the multiple factors governing the decomposition process, especially under similar climate conditions (Cotrufo et al., 2009; Hättenschwiler et al., 2005).

Besides, we confirmed our first specific hypothesis: after 9 and 12 months of field exposure of the litter, organic management always enhanced higher decomposition rates than both conventional managements. This finding agrees with that reported by Fließbach et al. (2000), one of the few previous research studies about litter decomposition in organic farming. Those authors found higher percentages of carbon respired in soil of organic farming than in soil of conventional systems, and concluded to the higher efficiency of the soil microbial community with respect to substrate use for growth in organic system. However, Diekötter et al. (2010) did not find significant differences in litter decomposition between organic and conventional management systems. In the present study, higher decomposition rates observed in organic farming show that management practices associated with organic agriculture were able to enhance a key function that regulates ecosystem carbon storage and plant nutrient acquisition and, therefore, enhances plant productivity (Berg and McClaugherty, 2008).

As postulated in our second hypothesis, both management systems that buried the litter in the soil profile (ORG and CT) encouraged higher decomposition rates than the systems in which litter remained on the surface (GR and NT). These results are consistent with Beare et al. (1992), who concluded that litter placement can strongly influence the decomposition process, mainly because when buried it maintains higher water content and supports greater densities of all microorganisms and soil fauna. However, our results also clearly show that litter placement can be a crucial but not an exclusive factor in determining decomposition, given that residues were buried in both management systems with conventional tillage – organic and conventional farming –, but decomposition was always higher in organic farming. These results suggest that, as predicted by our third hypothesis, soil biota plays a key role in the promotion of litter decomposition in organic fields. Indeed, the higher decomposition rate in ORG with respect to CT was related to the higher soil fauna abundances found in the organic system with relation to the conventional tillage system ($R^2 = -0.54$, $p = 0.02$, Pearson correlation analysis).

Collembolans and earthworms were independently analyzed because they are two of the most representative taxa of mesofauna and macrofauna respectively, they are also easy to identify and they are both related to the decomposition process (Petersen, 2002; Lavelle et al., 2006). Wickings et al. (2011) suggest that differences in soil communities would explain differences in decomposition rates between agricultural management systems, and proposed that soil carbon and litter decomposition models might be improved by including decomposer communities and their effects on decomposition. The higher faunal abundances found in organic farming than in conventional farming agree with findings reported for macrofauna (Birkhofer et al., 2008), for collembolans and earthworms (Bettiol et al., 2002) and for beetles (Döring and Kromp, 2003; Clark et al., 2006). Our results are particularly interesting considering the organic system analyzed did not include several practices which have been recognized as particularly positive for soil biota, such as manure application, low tillage intensity and high crop diversity, unlike many other agroecological management systems on small-scale (Altieri et al., 2012). Thus, it can be suggested that the non-use of agrochemicals was enough to produce shifts in soil faunal communities, which were further reflected in changes in decomposition dynamics.

Unexpectedly, decomposition rates were in general similar in no-tillage and grassland. Considering that there were no differences in Collembolan abundances between these management systems, a relationship between this group and the decomposition process could be suggested ($R^2 = -0.53$, $p = 0.02$, Pearson correlation analysis), as in the case of organic farming with respect to conventional farming. However, this association was not observed either with total soil meso and macrofauna or with earthworms, which were noticeably more abundant in grassland than in no-tillage. This result is likely related to a greater influence of macrofauna on buried litter, whereas in the systems where litter is on the surface, differences in decomposition rates due to changes in soil fauna are less noticeable and more related to meso- than to macrofauna.

With regard to our fourth hypothesis that the contribution of macrofauna would increase decomposition, results were not conclusive because of the interaction of this factor with the management system, the litter type and the time of field exposure. Overall, macrofauna increased decomposition mainly in the first stage of decomposition (until 4 months) but at subsequent stages (from 4 to 9 and for 9 to 12 months) the influence of the macrofauna inclusion in the decomposer community was smaller. This was so except for the control litter decomposition in ORG which was always higher when macrofauna was comprised in the decomposer community. These results disagree with several studies (Cortez and Bouché, 1998; Milton and Kaspari, 2007; Domínguez et al., 2010), according to which we expected that macrofauna activity would cause higher decomposition rates throughout the process. However, the importance of macrofauna during the first stage of decomposition is also expected, because in that moment it favours litter degradation both directly, by litter consumption and fragmentation, and indirectly, by promoting access to the remainder community (Hättenschwiler et al., 2005). Instead, on the following stages, litter is likely already more degraded and decomposition is produced mainly by soil mesofauna, microfauna and microorganisms. Similarly, there is evidence that decomposition enhancement due to mesofaunal activity does not occur at the first stage of decomposition (Ke et al., 2005). Also, our results agree

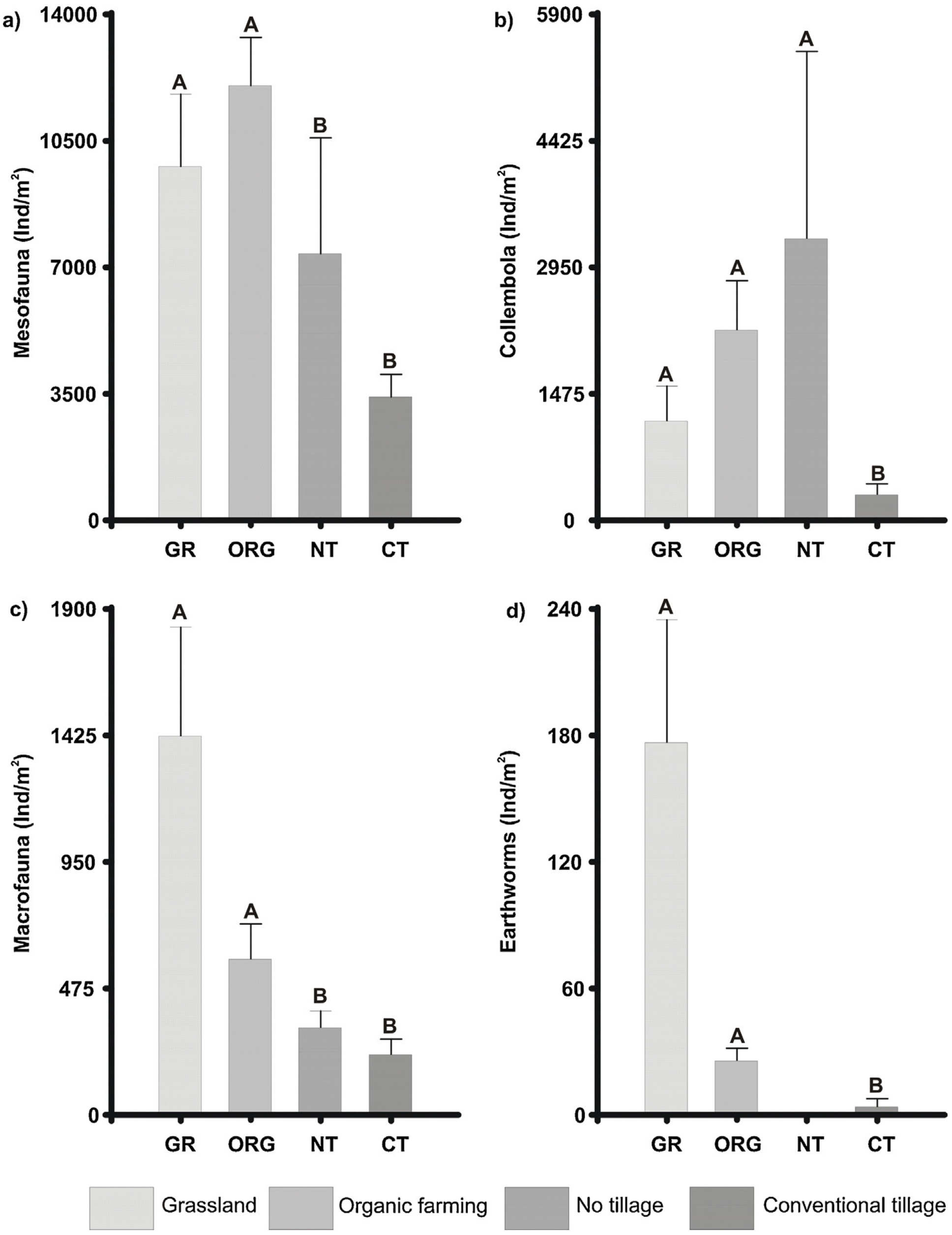

Fig. 2. Effect of the management system on soil mesofauna and macrofauna abundances. Bars represent the standard deviation (SD). Means with the same letter are not significantly different ($p < 0.05$).

with Hättenschwiler et al. (2005) who concluded that although soil fauna can significantly influence litter decomposition, no general or predictable pattern has emerged about how that relation occurs.

Regarding our last hypothesis that the local litter would decompose more rapidly than an allochtonous litter, our results were not conclusive. Overall, differences in decomposition between local and control litter were slight, although some differences depending on management or fauna or time, were found. So, this research was not able to certainly prove the ‘home field advantage’. This phenomenon implies that high decomposition results from local adaptation of the soil community to litter produced by the plant species above them (Ayres et al., 2009). However, it has been studied mainly in forests. The absence of ‘home field advantage’ in most cases of the studied agricultural sites may be due to the use of crop rotation and the consequent relatively short time of crop establishment, which enhances soil communities composed mainly of generalist organisms and therefore without any preference for the local litter of each field. On the other hand, the absence of differences in decomposition rates can be taken as a robust characteristic of the present results. Thus, the observed differences in terms of the decomposition process between organic and conventional farming systems were independent of litter type, and therefore the results may be generalized to a wide spectrum of crop residues.

5. Conclusion

This is one of the few studies providing field-based evidence on the effects of organic farming on litter decomposition process. This study confirms that soil meso- and macrofauna communities are benefited by organic agriculture and establishes that litter decomposition – a key ecosystem function – is enhanced by organic agriculture. Besides, this study shows that those benefits of organic farming are also held in extensive organic farms, with higher tillage intensity and lower crop diversity than small-scale agroecological farms. So, our findings increase the knowledge on the benefits of extensive organic farming on soil functioning, specifically in the case of litter decomposition, which plays a key role in the ecosystem services provision like nutrient cycling and primary production (Lavelle et al., 2006; Berg and McClaugherty, 2008).

Furthermore, this study is a valuable contribution to the need of identifying land use and soil management options that lead to favourable trade-offs between agricultural productivity and the provision of ecosystem services (Barrios, 2007), thus becoming a crucial implication of this research. Moreover, this study constitutes a useful tool for the promotion of the benefits of organic agriculture development not only among scientists and producers but also among decision-makers. Indeed, if we truly aim to address the current challenges related to agricultural production, government policies should consider the findings of studies like the present one to make decisions aimed at changing the paradigm of conventional agriculture into environmentally healthier production forms.

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