SOIL ORGANISMS IN ORGANIC AND CONVENTIONAL CROPPING SYSTEMS

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ABSTRACT: Despite the recent interest in organic agriculture, little research has been carried out in this area. Thus, the objective of this study was to compare, in a dystrophic Ultisol, the effects of organic and conventional agricultures on soil organism populations, for the tomato (*Lycopersicum esculentum*) and corn (*Zea mays*) crops. In general, it was found that fungus, bacterium and actinomycet populations counted by the number of colonies in the media, were similar for the two cropping systems. CO_2 evolution during the cropping season was higher, up to the double for the organic agriculture system as compared to the conventional. The number of earthworms was about ten times higher in the organic system. There was no difference in the decomposition rate of organic matter of the two systems. In general, the number of microartropods was always higher in the organic plots in relation to the conventional ones, reflectining on the Shannon index diversity. The higher insect population belonged to the Collembola order, and in the case of mites, to the superfamily Oribatuloidea. Individuals of the groups Aranae, Chilopoda, Dyplopoda, Pauropoda, Protura and Symphyla were occasionally collected in similar number in both cropping systems.
Key words: soil microorganisms, organic agriculture, microartropods, cropping systems, environmental impacts

ORGANISMOS DO SOLO EM SISTEMAS DE CULTIVO ORGÂNICO E CONVENCIONAL

RESUMO: Apesar do crescente interesse pela agricultura orgânica, são poucas as informações de pesquisa disponíveis sobre o assunto. Assim, num Argissolo Vermelho-Amarelo distrófico foram comparados os efeitos de sistemas de cultivo orgânico e convencional, para as culturas do tomate (*Lycopersicum esculentum*) e do milho (*Zea mays*), sobre a comunidade de organismos do solo e suas atividades. As populações de fungos, bactérias e actinomicetos, determinadas pela contagem de colônias em meio de cultura, foram semelhantes para os dois sistemas de produção. A atividade microbiana, avaliada pela evolução de CO_2, manteve-se superior no sistema orgânico, sendo que em determinadas avaliações foi o dobro da evolução verificada no sistema convencional. O número de espécimes de minhoca foi praticamente dez vezes maior no sistema orgânico. Não foi observada diferença na taxa de decomposição de matéria orgânica entre os dois sistemas. De modo geral, o número de indivíduos de microartrópodos foi superior no sistema orgânico do que no sistema convencional, refletindo no maior índice de diversidade de Shannon. As maiores populações de insetos foram as da ordem Collembola, enquanto para os ácaros a maior população foi a da superfamília Oribatuloidea. Indivíduos dos grupos Aranae, Chilopoda, Dyplopoda, Pauropoda, Protura e Symphyla foram ocasionalmente coletados e de forma similar entre os sistemas.
Palavras-chave: microbiota do solo, agricultura orgânica, microartrópodos, sistemas de cultivo, impacto ambiental

INTRODUCTION

Contamination of the water-soil-plant system with pesticides and fertilizers, in addition to breaking up the soil structure due to inadequate use of machinery and implements, is one of the main problems caused by intensive agriculture. The implementation of integrated cropping systems and the reduction of the external energy requirements have been suggested to minimize these problems. The organic cropping system is defined as a production system that is sustainable in time and space, by means of management and protection of the natural resources, without the use of chemicals that are aggressive to humans and to the environment, retaining fertility increases, soil life and biological diversity. Thus, the use of highly soluble fertilizers, pesticides and growth regulators must be excluded in this system (Paschoal, 1995). Not only does the system have to satisfy the need for reducing the environmental negative-impact problems caused by intensive agriculture, it must also be economically competitive. In comparing the organic and the conventional cropping systems, an important step is to establish which social, economic and ecological factors influence the production systems the most. Besides, a knowledge of those factors allows for a better understanding of how the production systems are structured and how they work.

With respect to the biological activity, in studies to compare the conventional, integrated and organic cropping systems, Bokhorst (1989) found that the number

of worms in a soil planted with sugar beets was five times higher in the organic system than in other systems, and that the percentage of wheat and potato roots infected with arbuscular mycorrhizae was twice as high in the organic as compared to the conventional and integrated systems. Gliessman et al. (1990, 1996), working with similar objectives, compared conventional and organic strawberry cropping systems in areas where farmers became organic producers, and verified an increase in the number of plants infected with mycorrhizae. Swezey et al. (1994) found higher microbial biomass in the soil and in arbuscular mycorrhizae in the organic system than in the conventional, in an area being changed from conventional into an organic apple growing area. All these studies emphasize the biological elasticity in the organic systems as a fundamental characteristic, influencing the occurrence of pests and diseases.

With regard to soil organisms, Brussaard et al. (1988, 1990) verified that the total biomass of soil organisms was higher for the integrated than for the conventional cropping system, with figures averaging 907 kg C ha^{-1} and 690 kg C ha^{-1}, respectively. Of these biomasses, bacteria accounted for over 90%, fungi represented approximately 5% and protozoa were less than 2% of the total biomass. El Titi & Ipach (1989) studied the effect of a cropping system with low input rate index as well as the conventional system on the soil fauna components and observed there were smaller populations of nematodes pathogenic to plants, higher worm biomass, and larger populations of collembolans and Mesostigmata mites in the system with low input index. Collembola is a microarthropod related to the soil's capacity to suppress *Rhizoctonia solani* (Lartey et al., 1994). Rickerl et al. (1989) found that populations of this organism were 29% larger in soils under minimum tillage as compared to soils under conventional tillage. Ladd et al. (1994) verified that the C biomass of microbial populations was greater in soils under crop rotation than in soils under continuous monoculture; greater in soils where plant residues were incorporated or remained on the soil surface than where they were removed; and smaller in a nitrogen-fertilized soil than in non-fertilized ones. This information is important because these are characteristics that contribute to soil biological equilibrium, nutrient mineralization and suppressive capacity toward plant pathogens, among others, making the system less dependent on external input.

The objective of this work was to evaluate the influence of the organic and the conventional cropping systems, for tomato and corn, on the community of soil organisms.

MATERIAL E METHODS

The experiment was carried out in Jaguariúna, SP, Brasil, latitude 22° 41' S, longitude 47° W Gr., and an altitude of 570 m, on a dystrophic Ultisol, with the following chemical properties of the 0-0.2 m topsoil layer, before liming: pH ($CaCl_2$) 4.4; OM 0.6%; P (resin) 1 μg cm^{-3}; K 0.5; Ca 7; Mg 7; H + Al 28; CEC 43 and S 15 mmol dm^{-3} of soil; and V 35%. The studies were conducted from January 1993 to September 1995.

The experiment was set up as randomized blocks with six replicates, and plots measuring 25 x 17 m. Tomato planting pits were spaced 0.5 m apart with 1.20 m between rows. Each plot was split in two halves, the first 12.5 x 17 m-half being planted with the variety Débora and the other planted with the variety Santa Clara. Therefore, each of the twelve rows contained 17 planting pits for each variety. The edging between plots was 10 m wide and was planted with sorghum. Two tomato plants were transplanted per pit. The tomato crop was conducted using the stake system, with one or two stems/plant. The number of stems was determined based on the successful establishment of the seedlings. Furrow irrigation and plant pruning were performed as often as necessary.

The entire area received 4.2 t ha^{-1} lime and 2 kg per meter, 110 and 12 days before planting, respectively. Fertilization in the organic system employed 2.5 L of organic compost (pH=6.4; C=29.6%; N=1.6%; P_2O_5=1.8; K_2O=0.17% and U=25.3%) plus 130 g of single superphosphate/pit; additionally, 2.5 L of organic compost, 60 g of single superphosphate, and 60 g of dolomitic lime/pit were applied as sidedressing; plants were sprayed twice a week with biofertilizer (Bettiol et al., 1997), at concentrations of 5 or 10%. In the conventional system, fertilization consisted of 200 g 4-14-8 (NPK)/pit and, after planting, a sidedressing application of 30 g N, 33 g K and 10.5 g P/pit; 52 days after planting and beyond, plants were sprayed once a week with foliar fertilizer [5-8-0,5 (NCaB)] at a rate of 3 mL L^{-1}.

In the conventional system, 0.15g/pit of active ingredient of the insecticide carbofuram were applied before planting. According to the procedures utilized by conventional local growers, a blend of insecticides, fungicides and miticides was sprayed twice a week, after planting. Active ingredients of fungicides sprayed during the crop cycle were metalaxyl, mancozeb, chlorothalonil, copper oxychloride, kasugamycine, cuprous oxide, methyl thyophanate, iprodione, benomyl, cymoxamil, maneb and monohydrate zinc sulphate, at the rates recommended by the manufacturers. Insecticides used were deltamethrin, permethrin, methomyl, methamidophos, acephate, avermectin and cartap, also at the recommended rates.

Extracts of black pepper, *Eucalyptus*, garlic and fern; Bordeaux mixture, and biofertilizer were applied twice a week (Bettiol et al., 1997; Abreu Junior, 1998) to control diseases and pests in the organic system. These applications were performed according to the program adopted by organic producers in the region.

Weed control was carried out by mechanical weeding and with the herbicide glyphosate (directed spray) on post-planting in the conventional system, and with mechanical weeding in the organic system.

After harvesting the tomato the area was planted with 'BR 201' corn; sowing occurred 178 days after planting the tomatoes. The organic system plots received an application of 4 m^3 of organic compost and single superphosphate at the rate of 20 g per meter; in addition, the biofertilizer was sprayed at 10% as sidedressing. In the conventional system fertilization consisted of 500 kg ha^{-1} of the 4-14-8 NPK rate applied pre-planting and 15 g m^{-1} urea as sidedressing. Weed control used the herbicide paraquat (directed spray) in the conventional system, and mechanical weeding was used in the organic.

After harvesting the corn, 'Débora' tomatoes were again cultivated, as previously described. Transplantation was made 401 days after the initial tomato planting.

Soil Microorganisms

A sample composed of 20 sub-samples of soil taken at the planting row from the 0-7 cm-depth layer was obtained for each plot. Samples were placed in plastic bags and immediately transported to the laboratory. Assessments were performed within 24 hours after collecting the samples.

Populations of fungi, bacteria and actinomycetes: The populations of fungi, bacteria and actinomycetes were quantified through the serial-dilution method, followed by plating in culture medium. Martin's culture medium (Tuite, 1969) added of 100 mg mL^{-1} streptomycine was used for fungi; for bacteria, the agar nutrient medium added of nistatin (42 mg L^{-1}) was used; for the actinomycetes, the alkalized agar-water medium was utilized. Aliquots (0.1 mL) from three dilutions, for each soil sample, were transferred to the culture media in three replications. Assessments were performed by counting the number of colonies per Petri dish and expressed as colony-forming units/g of dry soil (CFU g^{-1} dry soil).

Total respiratory activity: Total microbial respiration was evaluated according the method described by Grisi (1978). Soil samples (200 g) were incubated for 10, 20, and 30 days within tightly sealed containers holding 10 mL of a 0.5 mol L^{-1} (10 mL) KOH solution. At 10-day intervals, the solution was substituted and titrated with 0.1 mol L^{-1} of HCl. Incubation was conducted in the dark, at 25°C. This parameter was expressed as g CO_2 (g dry $soil^{-1}$) (day^{-1}). Since the more substantial changes happened in the first days, only readings up to the tenth day were used to determine mean values. For the statistical analysis, data were transformed into square root (x + 0.5) and subjected to analysis of variance and Duncan's mean comparison test.

Soil microarthropods: Collecting was made with a Uhland-type, stainless steel auger 5 cm in diameter and 10 cm in height, totaling four samples per plot. Samples were placed in plastic bags and taken to the laboratory. Collecting was between 8:00 and 10:30 h, 82 days before and 325 days after the first tomato seeding, for a total of 16 evaluations. Extraction was according to Tullgren's modified method, which uses heat and desiccation to force the animals to leave the soil. Samples remained in the extractor for 72 hours. An alcohol:glycerin (1:1) aqueous solution was used for specimen preservation. After extraction, the animals were counted and separated into groups with the use of a stereoscopic microscope. Mites and other smaller animals were fixed on permanent slides for identification. Data were expressed as number of individuals per 785 cm^3 soil. Shannon's diversity index (Shannon & Weaver, 1949) was calculated for a better understanding of the variations in the soil microarthropod populations.

Organic matter decomposition rate estimate: The decomposition rate was estimated via loss of organic content from leaf litter confined in nylon bags, 20 x 20 cm, with a 1 mm mesh, where 10 g of elephant grass dried at 60°C for three days. The field-collected samples, were collected every 20 days and transported to the laboratory, dried at 105°C for 24 hours and ashed at 600°C for 4 hours. The loss of organic matter estimate was calculated using the equation described by Santos & Whitford (1981), which corrects for the adhesion of soil particles to the organic matter.

Evaluation of earthworms in the soil: The first evaluation was carried out 81 days before the first planting, *i.e.*, before plowing and liming. A hand excavator was used to collect samples; two samples were collected from each plot, up to a depth of 20 cm, with 20 cm diameter. Shortly after planting the tomatoes, and 90 days later, samples were taken at about 40 cm depth, with a diameter of 10 cm. Three samples were collected from the compost: one from the pile surface; another at a layer up to 35 cm, and the third at a depth of 90 cm. The worm populations were determined 370, 407, and 471 days after the first tomato planting.

RESULTS AND DISCUSSION

The populations of fungi, bacteria and actinomycetes were similar for the two cropping systems over the entire period of study, with populations of fungi varying from 10^4 to 10^5, whereas populations of bacteria and actinomycetes varied from 10^5 to 10^7 CFU g^{-1} dry soil (Figure 1). Similar results were obtained by Castro et al. (1993), when several types of soybean management were compared, and by Cattelan & Vidor (1990) on soils cultivated with different crop rotation systems. Grigorova & Norris (1990) justified not adopting this method for evaluating soil microorganisms, because only a small fraction of microbial biomass could be cultivated on a selective medium. However, Cattelan & Vidor (1990) demonstrated the effectiveness of the method in studies with different cropping systems. In spite of a similar behavior in regard to microbial populations, starting 145 days after planting the tomatoes, the bacteria populations (Figure 1 C) were higher in the organic system as compared to the conventional. This could be due to soil plant cover, like Cattelan & Vidor (1990) who found a smaller bacterial population on naked as compared to cultivated soil.

Soil total respiratory activity continued higher in the organic system during the crop cycles, showing in some evaluations twice as much as the evolution observed in the conventional system (Figure 2). Differences were found during the intermediate period, that is, between 142 and 400 days after planting. There were no statistical differences between treatments at the initial periods or at the end. The higher respiratory rate in the organic system could be due to the addition of an exogenous source of organic matter to the soil and the consequent stimulation of heterotrophic microorganisms (Lambais, 1997).

Observed organic matter decomposition rates ranged from 15 to 45% of organic carbon loss in a 20-day period. Rodrigues et al. (1997) observed, in corn cultivated during the summer, values reaching 70% of carbon loss in a period of 30 days. There was no difference among results from the organic and the conventional systems (Figure 3). However, regardless of the system, there was an influence of time on the organic matter decomposition rate was, although no interaction between time and the treatments was found. This suggests that variations found during the study period could be related to the humidity and temperature fluctuations that occur in the field, thus providing no evidence that the adopted management forms influenced decomposition rate.

The CO_2 release method used in this study to evaluate respiratory activity favors the microorganism population, since soil manipulation can eliminate the majority of the microarthropod community. Several authors have, in microcosmos studies, demonstrated the role microarthropods in soil organic matter decomposition process. A low fungivore density (Collembola) has a stimulating effect on microbial respiration, whereas high densities inhibited microorganism respiration Barsdate et al, 1974; Hanlon & Anderson, 1979).

Mites and insects, belonging to various families, were the two main groups of arthropods found in the soil in 1993 and 1994 (Tables 1 and 2). In general, rates and numbers of individuals from these groups were higher in the organic cropping system, reflecting on Shannon's diversity indices, which were higher in the organic system on all sampling dates (Figure 4), but not on the soil organic matter decomposition (Figure 3).

The largest populations of insects were from the Order Collembola, and the number of individuals found in the organic system was three times as high as that in the conventional system, during the first nine months (Table 1). During the following six months, the number of collembolans remained 20% higher in the organic cropping system than in the conventional (Table 2). These data agree with El Titi & Ipach (1989), who verified larger populations of collembolans for the low-input system than for the conventional. Collembolans contribute to the soil's abilitity of suppressing plant pathogens such as *Rhizoctonia solani*, *Fusarium oxysporum* f. sp. *vasinfectum*, and *Pythium* (Wiggins & Curl, 1979; Curl et al., 1985a, b; Rickerl et al., 1989; Lartey et al., 1994),

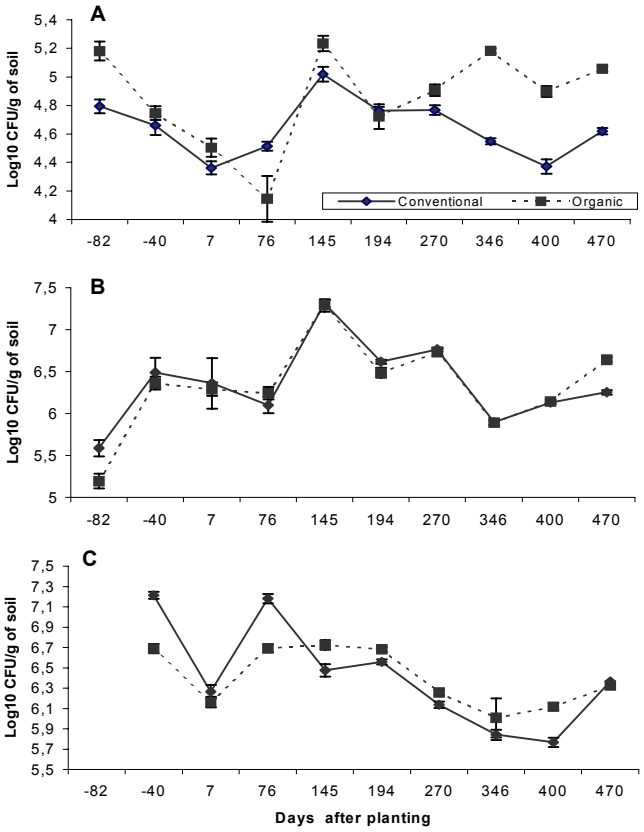

Figure 1 - Dynamic population of fungi, bacteria and actinomycetes in soil from organic (- - -) and conventional (—) cropping systems for tomato and corn. CFU: Colony Forming Units. A=Fungi; B=Actinomycetes; C=Bacteria. The data represent the mean of six replicates. The bars indicate the standart deviation.

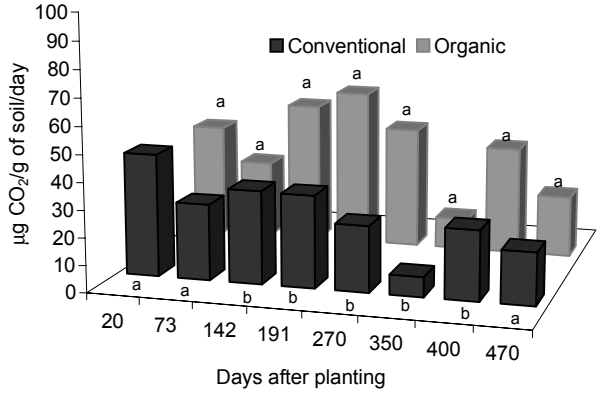

Figure 2 - CO_2 evolution from soil microorganisms of organic- and conventional systems for tomato and corn crops. Results were obtained though soil incubation at 25°C for 10 days. For each planting time, data followed the same letter did not differ (Duncan 5%).

because these organisms are, for the most part, mycophagous, modifying the community of fungi. Because in this work the practices in the organic system stimulated the community of collembolans, it can be inferred that these organisms are responsible, at least in part, for the suppression ability in soils enriched with organic matter. Still, in regard to insects, the number of individuals was low for the rest of the orders (Tables 1 and 2).

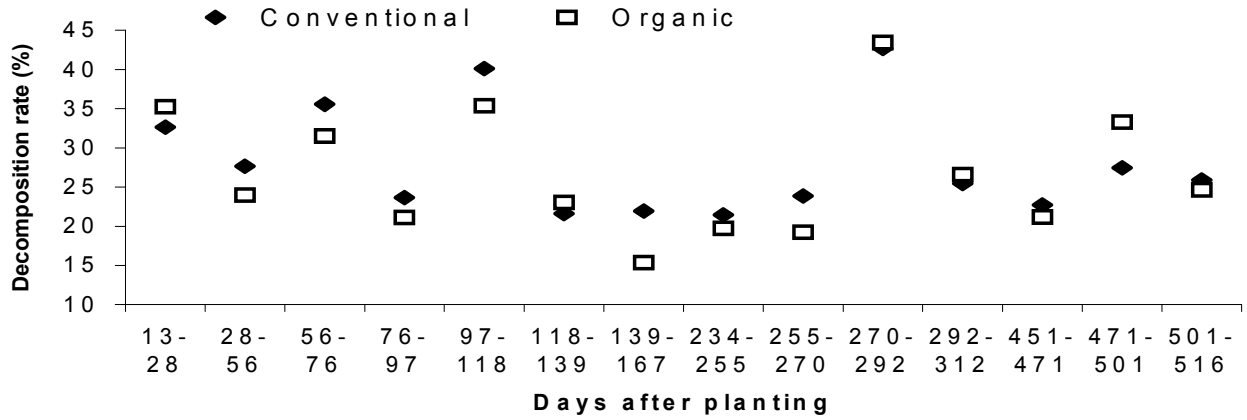

Figure 3 - Organic matter decomposition rate soil of organic and conventional cropping systems.

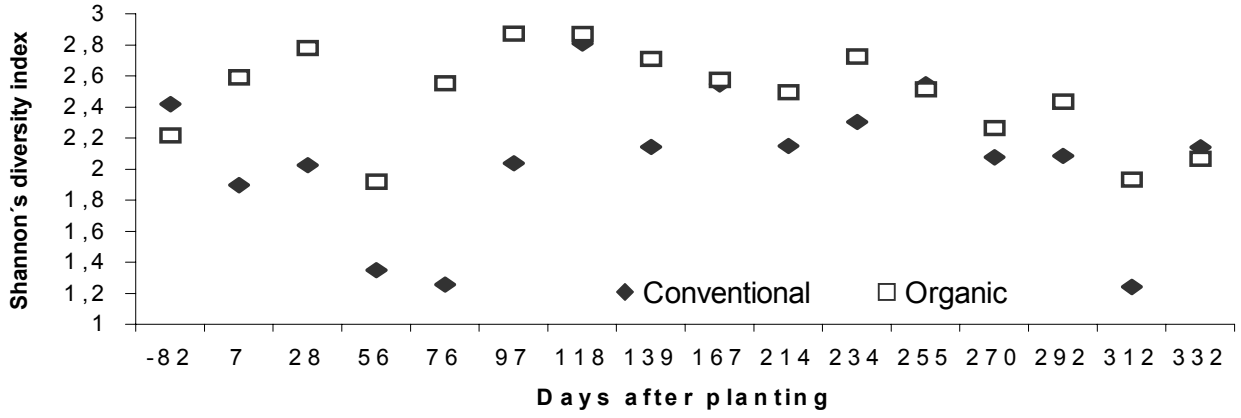

Figure 4 - Shannon´s diversity index for soil microarthropods of the organic and conventional cropping systems.

During the first nine months of evaluation (Table 1), for both cropping systems, the largest mite population was of the superfamily Oribatuloidea, followed by the family Galumnidae and by the superfamily Passalozetoidea, all in the suborder Oribatida and with similar behavior between cropping systems. In the suborder Gamasida the most abundant population was Laelapidae and in Actinedida the most abundant was Pygmephoridae, both more numerous in the organic system. Populations in the suborders Acaridida and Ixodida were very small. In the six subsequent months (Table 2), when only the families of mites were quantified, the largest population was of Scheloribatidae followed by Galumnidae, with similar behavior between the systems. The expressive number of individuals in the families Galumnidae and Scheloribatidae for both cropping systems is due to the characteristic these families exhibit toward occupying space in agroecosystems. In the orders Actinedida and Gamasida, families Cunaxidae and Laelapidae were the largest, respectively. In general, mite population densities in the classes Gamasida and Actinedida were higher in the organic system. The fact that the Gamasida showed high numbers is possibly due to a large Collembola population, because these organisms are a source of food for this class of mites. El Titi & Ipach (1989) verified the existence of larger populations of collembolans and Gamasida mites in the low-input system than in the conventional.

Due to the more abundance of microarthropods in the organic system, it was believed that the organic matter decomposition rate would be higher in this system, because these organisms contribute for organic matter degradation and stimulate microbial activity in the soil (Nosek, 1981). Accordingly, when the presence of Oribatida and Collembola in litterbags incorporated into the organic and the conventional systems was evaluated, a larger number of individuals in the litterbags was found for the organic system (Melo & Ligo, 1999), indicating that this system contributes for an increase in biological diversity. Since the presence of these organisms in larger numbers was not accompanied by a higher decomposition of organic matter, one can say that the differences in arthropod density found in the soil between the organic and the conventional systems did not reflect on the organic matter decomposition rate, as evaluated by the litterbag method. The community of microarthropods in the soil might have, among other factors, influenced microbial activity, since the organic system showed a higher microbial activity potential than the conventional system. The influence of the soil fauna on the organic matter decomposition rate of forest soils is well documented, but this is not true for agricultural ecosystems (Crossley et al.,

Table 1 - Number of soil microarthropods in the tomato organic (O) and conventional (C) cropping systems.

Class/Order	Superfamily/ Family	Days after the first tomato planting																	
		-84		7		28		49		70		91		112		134		162	
I-Arachnida		C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O	C	O
I.1 Acari	Anoetidae	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0
Acaridida	Acaridae	0	0	0	1	0	0	0	1	0	1	0	1	0	5	0	0	0	3
Actinedida	Cunaxidae	1	0	0	2	1	4	2	1	0	1	0	9	1	4	1	18	1	16
	Eupodidae	0	0	0	0	1	25	0	2	0	0	0	1	0	2	0	0	5	3
	Nanorchestidae	0	0	4	18	0	19	0	4	1	4	0	6	7	1	1	2	2	1
	Rhagidiidae	0	0	0	0	0	0	0	0	0	5	0	1	0	0	0	0	0	3
	Pygmephoridae	0	0	1	2	1	37	0	2	0	13	0	30	1	8	0	0	0	1
	Scutacaridae	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0
	Tarsonemidae	0	0	0	0	2	0	0	0	0	0	0	1	2	1	1	5	0	0
Gamasida	Ascidae	0	0	0	2	0	1	1	4	0	0	0	11	1	7	0	1	1	0
	Digamasellidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Laelapidae	1	6	1	9	1	8	4	7	1	15	3	13	2	27	1	5	4	2
	Macrochelidae	1	2	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0
	Ologamasidae	6	8	1	2	0	6	2	3	0	6	0	2	1	5	0	4	1	3
	Pachylaelapidae	12	20	0	2	0	2	0	2	1	0	0	3	0	1	0	0	0	0
	Parasitidae	0	1	0	1	1	1	2	0	0	5	0	2	9	5	2	0	0	0
	Parhoslaspididae	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Phytoseiidae	0	0	0	0	0	6	0	0	0	0	1	0	0	1	0	3	1	1
	Rhodacaridae	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Uropodidae	1	2	0	6	0	13	1	2	1	7	0	0	0	3	1	15	0	2
	Immature	0	0	0	5	0	5	6	10	0	8	4	20	9	14	0	3	3	8
	Male	4	6	0	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0
Ixodida	Ixodidae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oribatida	Brachichythonidadae	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Euphthiracaridae	0	1	1	3	0	2	0	1	1	0	0	1	0	3	0	1	0	0
	Galumnidae	15	14	20	33	26	22	17	22	10	16	6	10	12	19	3	14	6	9
	Haplochthoniidae	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0
	Microzetidae	0	0	0	0	0	0	2	0	0	1	0	1	0	2	1	1	0	0
	Oppiidae	0	0	2	4	2	11	3	13	2	4	3	5	16	3	0	0	1	0
	Oribatuloidea	21	66	46	46	23	47	106	78	38	26	33	26	18	31	40	28	56	17
	Oribatellidae	0	3	1	1	0	1	0	1	0	0	0	1	3	0	0	0	1	2
	Passalozetoidea	6	13	1	4	3	6	3	1	1	4	7	8	37	24	6	4	16	0
	Suctobelbidae	0	0	0	0	0	2	3	1	0	0	1	1	7	0	1	1	2	0
	Scheloribatidae	21	59	48	46	23	47	106	78	36	26	33	26	17	31	45	28	56	17
	Thrypochthoniidae	0	0	0	0	0	0	0	0	0	0	0	16	3	14	0	0	2	1
	Immature	0	0	0	1	0	2	1	0	1	0	0	0	0	1	0	0	0	0
	Oribatida	2	3	1	1	0	2	3	2	1	2	1	3	0	0	2	7	1	0
II.Insecta																			
Coleoptera	Carabidae	0	0	0	0	1	0	0	1	0	1	0	1	1	0	2	2	0	0
	Cicindelidae	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Hydroscaphidae	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	Nitidulidae	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0
	Scarabaedidae	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0
	Scolytidae	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
	Staphylinidae	0	0	0	0	2	1	0	0	0	0	0	3	5	5	0	1	2	4
	Larva	4	1	5	0	0	6	0	1	0	1	0	10	4	11	0	17	7	4
Collembola	Entomobryidae	7	10	0	2	2	43	0	0	0	0	1	19	36	30	26	35	32	52
	Isotomidae	4	1	5	71	3	93	0	0	0	0	2	38	16	60	5	2	12	32
	Poduridae	0	1	1	39	0	34	0	0	0	0	0	5	23	44	2	15	33	13
Diptera	Adult	0	0	5	5	10	11	0	0	0	0	9	19	9	12	5	8	21	20
	Larva	1	0	0	0	1	5	0	1	0	1	0	0	1	0	0	1	2	1
Homoptera		0	0	0	1	0	0	0	0	0	0	1	0	0	2	2	1	3	3
Hymenoptera	Formicidae	0	0	0	0	0	4	0	0	0	0	0	3	3	9	0	3	5	5
Psocoptera		1	1	1	0	1	0	0	0	0	0	2	1	2	0	1	2	0	1

Data expressed in number of individuals per 785 mL soil and represent the mean of six replicates.

Table 2 - Number of soil microarthropods in the corn organic (O) and conventional (C) cropping systems.

Class/order	Family	Days after the first tomato planting													
		197		218		240		262		284		304		325	
I-Arachnida		C	O	C	O	C	O	C	O	C	O	C	O	C	O
I.1 Acari	Anoetidae	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Acaridida	Acaridae	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Actinedida	Cunaxidae	4	9	8	7	17	17	16	14	7	17	7	18	6	8
	Erythraeidae	0	0	1	1	2	0	0	0	0	1	0	0	0	0
	Eupodidae	0	2	0	0	0	11	1	11	3	4	1	4	9	10
	Nanorchestidae	0	2	0	5	5	10	1	3	1	3	1	2	2	2
	Rhagidiidae	0	1	0	0	2	2	0	0	0	0	1	2	1	0
	Pygmephoridae	2	0	0	2	1	2	3	1	7	3	0	4	0	0
	Tarsonemidae	0	0	0	0	2	10	0	4	0	1	0	0	1	0
Gamasida	Ascidae	0	1	1	0	4	5	5	11	4	4	5	12	1	2
	Amoroseiidae	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	Digamasellidae	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	Laelapidae	3	1	2	13	17	48	44	41	5	20	1	18	7	12
	Macrochelidae	0	0	0	0	0	0	0	0	0	1	0	1	1	2
	Ologamasidae	1	4	1	1	2	5	9	12	6	5	5	4	4	7
	Pachylaelapidae	0	2	0	0	0	1	1	1	0	0	0	0	0	0
	Parasitidae	0	0	1	17	4	10	1	7	2	0	4	7	0	4
	Parhoslaspididae	0	1	0	0	3	0	0	0	0	0	0	1	0	0
	Phytoseiidae	0	0	0	0	1	0	4	1	0	5	4	4	2	0
	Rhodacaridae	0	0	0	0	0	0	0	4	0	1	0	7	0	1
	Uropodidae	0	15	0	37	2	24	1	8	1	27	0	17	0	1
	Immature	0	2	1	21	16	19	24	7	4	9	5	7	3	1
	Male	1	4	0	5	6	2	4	3	0	0	0	1	0	0
Oribatida	Brachichythonidadae	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	Euphthiracaridae	0	0	0	0	5	1	1	2	0	3	5	4	3	5
	Galumnidae	123	11	19	94	45	51	60	56	31	64	20	108	18	106
	Haplochthoniidae	1	0	0	0	0	0	0	0	0	00	0	0	0	0
	Microzetidae	0	0	0	1	1	0	1	5	0	0	0	0	0	0
	Oppiidae	0	0	0	0	7	2	0	5	1	1	1	0	0	0
	Oribatellidae	1	1	3	4	8	3	15	6	5	7	1	10	6	1
	Phthriracaridae	0	0	0	0	1	0	0	0	0	0	0	1	2	0
	Suctobelbidae	0	0	2	0	0	0	0	0	0	0	0	0	0	0
	Scheloribatidae	53	48	144	132	210	163	365	272	175	140	90	122	68	88
	Thrypochthoniidae	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	Immature	20	17	35	33	139	82	99	125	54	29	10	26	5	11
	Oribatida	0	4	3	4	15	4	1	2	1	0	0	4	2	4
II.Insecta															
Coleoptera	Carabidae	1	2	2	0	3	5	1	1	2	1	0	7	1	6
	Cicindelidae	0	1	3	2	0	0	0	0	0	0	0	0	0	0
	Nitidulidae	0	0	1	1	0	0	0	0	0	0	0	0	0	1
	Scarabaedidae	1	3	0	2	0	0	0	0	0	0	1	0	0	0
	Scolytidae	0	2	2	0	1	0	0	0	0	1	1	0	0	0
	Staphylinidae	1	2	1	4	7	6	1	0	0	0	0	0	0	0
	Larva	1	10	8	8	20	28	5	16	3	6	3	2	1	1
Collembola	Entomobryidae	0	8	10	30	21	41	15	13	2	23	1	0	0	1
	Isotomidae	15	104	29	41	81	266	223	326	125	137	516	451	69	92
	Poduridae	0	8	29	35	24	33	234	128	54	30	33	33	104	174
Diptera	Adult	31	68	20	24	7	6	5	16	7	2	4	8	7	1
	Larva	0	0	0	2	1	9	1	3	0	2	1	2	2	3
Hymenoptera	Formicidae	4	8	6	20	16	5	17	26	13	4	0	3	2	12
	Wasp	1	0	1	3	3	1	1	1	0	3	0	0	0	0
Psocoptera		15	12	7	22	0	0	0	0	1	2	1	0	0	1

Data expressed in number of individuals per 785 mL soil and represent the mean of six replicates.

1989). In agroecosystems the effect of the fauna on the organic matter decomposition rate seems not to be very significant and consequently, there are many points that need to be clarified when it comes to the role of fauna in agricultural soils. Occasionally, and similarly among the crop systems evaluated, individuals belonging in the groups Aranae, Chilopoda, Diploploda, Diplura, Pauropoda, Protura and Symphila were collected. In addition to these, individuals of the insect orders Dermaptera, Hemiptera, Homoptera, Isoptera and Thysanoptera were found in limited numbers.

The higher biological diversity in the organic system is important because it contributes to keeping the biological equilibrium, essential in an agroecosystem. This equilibrium may bring about greater stability for the system and consequently fewer problems with diseases and pests.

With respect to the worm community, after a one-year period of cropping, the soil in the organic system showed at least a ten-fold higher number of specimens per 3140 mL soil sample than the conventional system. After 370, 407 and 471 days from planting a total of 18, 24 and 101 specimens were found in the organic cropping system, and 1, 2 and 12 specimens were found in the conventional system, respectively. These data agree with Bokhorst (1989), who found that the number of worm individuals per square meter, in a soil planted with sugar beets, was five times higher in the organic system as compared to the conventional. Also, El Titi & Ipach (1989) observed the existence of greater worm biomass in a low-input system than in the conventional. The higher number of species in the organic system is possibly due to the availability of organic substrates for them to breed on and the absence of pesticides. On the other hand, the presence of pesticides explains the small number of species in the conventional system, since the worms are sensitive to the products used in the conventional system (Lee, 1985). These organisms are important because they not only improve the physical properties (Lee, 1985), but also contribute to the soil's ability to suppress pathogens, such as *R. solani*, among others (Stephens et al., 1993). No worm specimens were found in the recently plowed soil (81 days before planting) and in the evaluations carried out at planting time and 90 days after planting the seeding, as well as in the organic compost.

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