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Arthropod fauna associated with organic and conventional maize crop

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Abstract. The corn crop has a marked sensitivity to biotic and abiotic stresses. As a control method, basically, transgenic plants have been used in association with chemical control. However, frequent applications of insecticides affect the conservation of biodiversity, and consequently, the natural regulation of insect populations. Thus, the objective of the work was to compare the diversity of arthropodofauna associated with the cultivation of corn in organic and conventional systems. The experiments were carried out at Fazenda Nossa Senhora Aparecida, in Hidrolândia/GO, in two areas: one in a consolidated organic system and the other in a conventional system. The organic area (1 ha) was sown with the Creole variety Palha Roxa and no type of cultural treatment was carried out. The conventional area (10 ha) was sown with a transgenic hybrid resistant to the herbicide glyphosate 30F53VYHR and two chemical fertilizers were applied, for planting and cover, two applications of herbicides and an application of insecticide. To survey the arthropodofauna, in each area, two collections were made with six pitfall soil traps. The first collection was carried out in the vegetative stage and the second in the reproductive stage, approximately at 35 and 80 days after planting, respectively. The traps were kept in the field for a week. In addition, a collection with entomological net was carried out in 10 plants chosen at random. The collected insects were stored in plastic pots containing 70% alcohol and taken to the laboratory for quantification and identification. The data referring to the total of insects collected were submitted to the T test at 5% probability. In the two collected with pitfall traps, the largest number of arthropods was collected in the area of organic cultivation, with greater diversity of orders and families in this area. In the collection performed with entomological network, there was no difference between the places of cultivation. Organic crops provide better conditions for establishment and development for insects, especially those that spend some life in the soil. Therefore, the diversity of arthropods is greater in this cultivation system.

Keywords: organic agriculture, diversity, ecological balance, insects.

Introduction

Conventional agriculture is one of major human activities responsible for environmental degradation (Hole et al., 2005; Olanipekun et al., 2019). Several problems is related to this, mostly associated with simplification of landscapes due the monocultures establishment (Pogue & Schnell 2001), such loss and change on habitats and biodiversity, predatory exploration of resources, introduction of exotic species in ecosystems, pests outbreaks, and others (Butler et al. 2007; Chivian & Bernstein, 2008). Conventional agriculture system can be characterized by frequent and intense disturbances, jeopardizing the conservation of natural enemies

(Letourneau, 1998). The indiscriminate use of different pesticides in these systems directly affects the arthropod diversity and threat the natural biological control.

Organic systems of production, where these synthetic pesticides are not used, offer a more conducive condition to establish and maintenance of natural enemies (Swezey et al., 1999; Fujita, 2000; Letourneau & Goldstein, 2001). Organic cultivation is based on establish of ecological and balanced agricultural systems, stable, productive, and efficient in using natural resources, that result in health food free of chemical residual (Paschoal, 1994). Therefore, environmental balance is extremely in

organic agriculture, once maintaining beneficial organisms is essential to natural control of pests in crop areas.

Maize (*Zea mays*) is a very important cereal due its nutritional characteristics and versatility of use. It may be used as to animal feed production as the high-tech industry (Cruz et al., 2006). This crop is sensible to biotic and abiotic stress, such season of sowing, light and water availability and incidence of pests and pathogens (Andrade, 1995; Lozada & Angelocci, 1999; Forsthofer et al., 2006). *Spodoptera frugiperda* (Smith) (Lepidoptera: Noctuidae) is one of mainly pests on maize crops.

Several beneficial insects act as natural control of pests as *S. frugiperda* (Lepidoptera: Noctuidae), reducing its population and the damage caused by this caterpillar (Cividanes & Barbosa, 2001; Cruz, 2008). Parasitoids of Hymenoptera e Diptera (Figueiredo et al., 2006; Cruz, 2008) and predators such ladybugs, chrysopids, sirphids, predator bugs and earwigs (Cruz, 2008). The earwigs *Doru luteipes* specie (Scudder) (Dermaptera: Forficulidae), e.g., is an efficient predator of *S. frugiperda* (Picanço et al., 2003).

Periodic survey of arthropod fauna during the crop cycle is an important tool to study and development of new techniques of management, allowing the identification of potential pests and their natural enemies. Therefore, the objective of this study was compare the diversity of arthropod fauna associated to maize crop under organic and conventional systems.

Methods

Experiments were conducted in two areas: Nossa Senhora Aparecida farm, located in Hidrolândia-GO (16° 57' 58" S; 49° 11' 13" W; 800 meters altitude), certified for organic production, and a conventional area near. In organic system the genotype used was Palha Roxa in 1 ha; and in conventional, the transgenic hybrid 30F53VYHR, resistant to herbicide glyphosate, in 10 ha.

In the organic area, no fertilization or cultivation practice was carried out after planting. In conventional system two fertilizations were made using NPK 08-28-16 and NPK 08-28-16, in 300 kg ha⁻¹. Weed control was made with atrazine (3 L ha⁻¹) and glyphosate (2.5 L ha⁻¹). Besides, an insecticide application (pyrethroid) was made to *S. frugiperda* control at 40 days after planting.

To evaluation the arthropod diversity on soil, collections were made with pitfall traps. Pitfall traps were made with 15 cm pet bottles buried at the soil level, containing water and 1% detergent to break the surface tension of the water and kill the captured insects. Two collections were made in these traps, one at vegetative phase (35 days after planting) and one at reproductive phase (80 days after planting). Six traps was installed in each area. In each area, half of pitfall traps was allocated between two lines of crop, at 50 m distant for each other. The other half was allocated in this same arrangement, 50 lines far from the first half of pitfall traps.

Diversity of aerial insects was assessed by a collection with the entomological in the reproductive phase, in ten plants randomly chosen in each area. All collected arthropods (pitfall and entomological net) were allocated in plastic pots containing 70% alcohol, and then and quantified and identified at laboratory. Data on total of insects collected were submitted to the T test with a probability of 5%.

Results and discussion

Highest arthropod of soil diversity was found in organic areas. Several species of collected families pass at least a part of its life cycle on soil. Agroecological management of soil favors the arthropod fauna development due the higher content of organic matter, providing greater stability of soil temperature and humidity (Gassen, 1996; Silva & Carvalho, 2000). At first collection in pitfall traps, 258 arthropods were found in organic area, whereas 118 individuals were collected in conventional area (Figure 1). Mean of individuals was higher in organic area, reaching 43.00 individuals/trap, while conventional area resulted in 19.67 individuals/trap ($t=-1.82$; $df= 10$; $P\leq 0.05$). Diversity of orders and families were higher in organic system, where were found six orders and ten families of arthropods (Table 1). Most frequent families were Formicidae (76.74%), Acrididae (9.03%) and Scarabaeidae (6.59%). At conventional area, only three orders and three families were observed: Formicidae (94.07%), Araneae (4.24%) and Coreidae (1.69%) (Table 1).

The orders Hymenoptera and Orthoptera were the most abundant in organic area. This confirm the importance of this management to soil quality, once lot of these insects search for favorable environments, digging galleries and, consequently, benefiting the infiltration of rainwater and the exchange of gases between the soil and the atmosphere (Silva, 1994). In conventional areas, predominant insects are the good flying adults that development occur in the aerial part of plants (Gassen, 1996).

In second collection, same trend was observed. Organic area totalized 211 individuals, while in conventional area were found 48 arthropods. Mean of arthropods in organic area was higher than in conventional area, with 35.16 individuals/trap and 8.00 individuals/trap ($t = -3.84$; $df = 10$; $p\leq 0.05$), respectively (Figure 2). Eight orders and 11 families of arthropods were collected in organic area. The orders Hymenoptera (61.14%) and Orthoptera (26.54%) and the families Formicidae (61.14%), Acrididae (25.11%) and Scarabaeidae (6.16%) were the most frequent observed. In conventional area, half of orders were found (Hymenoptera (85.42%), Orthoptera (6.25%), Coleoptera (6.25%) and Araneae (2.08%)). Families most frequent in conventional system were Formicidae (85.42%), Acrididae (6.25%), Chrysomelidae (4.17%), Tenebrionidae (2.08%) and Araneae (2.08%) (Table 1).

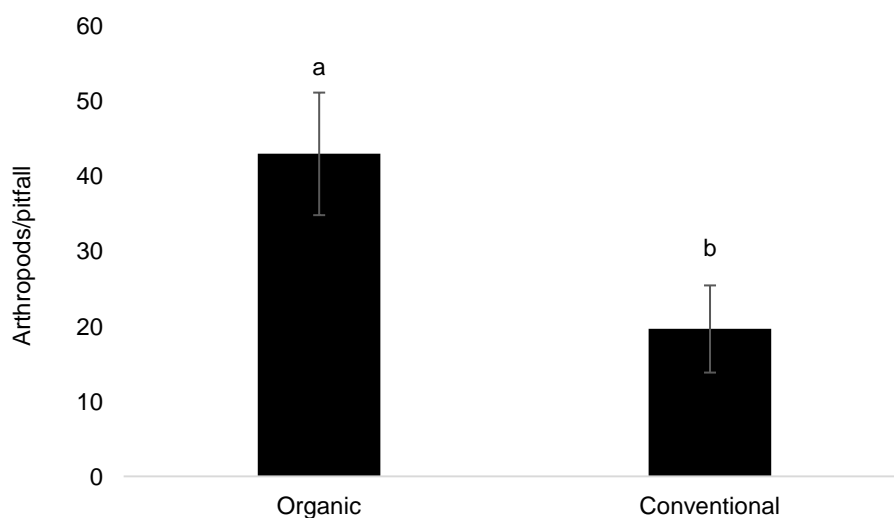


Figure 1. Means of arthropods/pitfall in two areas of maize cultivation (organic and conventional), in first collection. Bars followed by different letters differ by the T test ($P \leq 0.05$). Hidrolândia/GO.

Table 1. Number of arthropods collected and percentage of orders and families in two areas of cultivation (organic and conventional) collected in pitfall on first and second evaluation. Hidrolândia/GO.

Order	Family	First collection				Second collection			
		Organic		Conventional		Organic		Conventional	
		N ^o	%	N ^o	%	N ^o	%	N ^o	%
Araneae	UNF*	1	0.39	5	4.24	5	2.37	1	2.08
Coleoptera	Carabidae	3	1.16	-	-	-	-	-	-
	Chrysomelidae	-	-	-	-	-	-	2	4.17
	Scarabaeidae	17	6.58	-	-	13	6.16	-	-
	Tenebrionidae	-	-	-	-	-	-	1	2.08
Dermoptera	Forficulidae	-	-	-	-	2	0.95	-	-
Diptera	UNF*	3	1.16	-	-	-	-	-	-
	Syrphidae	-	-	-	-	3	1.42	-	-
Hemiptera	Alydidae	1	0.39	2	1.69	2	0.95	-	-
	Cercopidae	3	1.16	-	-	-	-	-	-
	Coreidae	-	-	-	-	-	-	-	-
	Cydnidae	1	0.39	-	-	-	-	-	-
	Pentatomidae	-	-	-	-	-	-	-	-
Hymenoptera	Formicidae	198	76.74	111	94.07	129	61.14	41	85.42
Neuroptera	Chrysopidae	-	-	-	-	1	0.47	-	-
Orthoptera	Acrididae	24	9.30	-	-	53	25.11	3	6.25
	Gryllidae	7	2.71	-	-	3	1.42	-	-
Total		258	100	118	100	211	100	48	100

* Unidentified family.

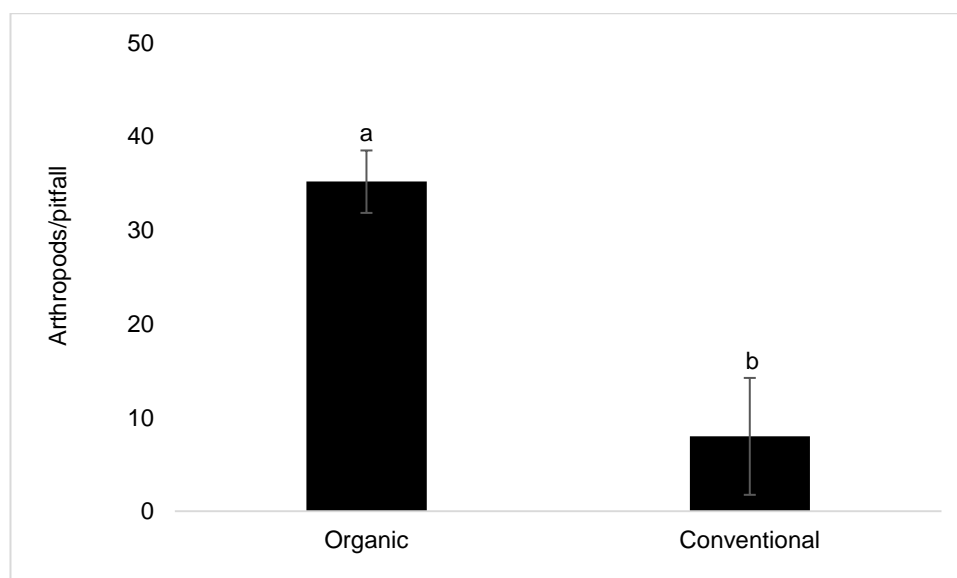


Figure 2. Means of arthropods/pitfall in two areas of maize cultivation (organic and conventional), in second collection. Bars followed by different letters differ by the T test ($P \leq 0.05$). Hidrolândia/GO.

In the collection with entomological net, the number of arthropods was 58 and 63 individuals in organic and conventional area, respectively. Mean of individuals did not differ between the areas ($t = 0.30897$; $df = 18$; $p = 0.6196$). Four families from four orders were found in organic area (Coleoptera: Chrysomelidae (3.45%), Dermaptera: Forficulidae (93.11%), Diptera: Ulidiidae (1.72%) and Hemiptera: Cercopidae (1.72%)). Arthropods found in conventional area were from three orders and three families: Dermaptera (Forficulidae 90.48%), Diptera (Ulidiidae 6.35%) and Hemiptera (Pentatomidae 3.17%) (Table 2).

Community insects associated to maize crop vary according the region, season of planting and plant phase of development. At summer, harvests present greater diversity when compared to the off-season and winter harvests (Frizzas et al., 2003). Predators more abundant in maize plants is

of families Forficulidae, Anthocoridae, Chrysopidae, Coccinellidae, Geocoridae and Formicidae (Badji et al., 2004), as observed in this study, for both areas. *Doru luteipes* (Dermaptera: Forficulidae) is the natural enemy more damage (Picanço et al., 2003). Likewise our results, organic management increased abundance and diversity of arthropod in sugarcane crops (Santos et al., 2017).

Biodiversity involves the amount and richness of different species in the space and time on determinate system (Gliessman, 2001), offering ecological benefits to the ecosystem. The interaction between the biotic environmental components might be used to induce a positive and direct effect on biological control by providing food and shelter source to natural enemies that guarantee the pest population in balance (Altieri et al., 2003; Aguiar-Menezes, 2004).

Table 2. Number of arthropods collected and percentage of orders and families in two areas of cultivation (organic and conventional) in entomological net. Hidrolândia/GO.

Order	Family	Organic		Conventional	
		Nº	%	Nº	%
Coleoptera	Chrysomelidae	2	3.45	-	-
Dermaptera	Forficulidae	54	93.11	57	90.48
Diptera	Ulidiidae	1	1.72	4	6.35
Hemiptera	Cercopidae	1	1.72	-	-
	Pentatomidae	-	-	2	3.17
Total		58	100	63	100

Organic system of production search to manage the soil fertility by organic fertilizations (compost of vegetable and animal residuals), green

adubation (leguminous and others), minerals fertilizers of low solubility and other products (Mapa, 2011). These techniques contribute directly to the

insects in this system. Several environmental impacts caused by conventional agriculture might be solved or minimized by this type of management, resulting in higher ecological balance, and consequently, equilibrium phytosanitary (Bonilla, 1992).

Loss in maize productivity vary with the environmental interference and pests and its natural enemies incidence, influencing the amount of attack and the expression of damage. In more balanced systems, the population density of phytophagous insects is regulated by the presence of beneficial organisms that decrease the damage potential of insects (Cividanes & Barbosa, 2011).

Conclusion

Amount and diversity of soil arthropods is greater in organic system of cultivation.

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