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Effect of Cabrio® Top and Macuco Bean (Pachyrhizus spp.) Extracts on Soil Mesofauna

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Abstract**—** *Macuco bean (Pachyrhizus spp.) Is an atypical horticulture that has toxicity in its seeds and has potential for disease control, but its effect on soil stability is unknown? Among the bioindicators to evaluate soil quality is the analysis of fauna diversity, considered to be the most sensitive for presenting rapid response to changes. Therefore, the objective of this study was to determine the effect that macuco bean extracts and Cabrio® Top fungicide have on the soil mesofauna, with a completely randomized block design with three treatments and six replications. The treatments were: bean extract (1: 1000), a solution of Cabrio® Top (1: 250) and the water control. Pipes 100 mm in diameter were inserted into the soil 10 cm deep, one pipe being the experimental unit. For the extraction of mesofauna the Berlese-Tullgren method was used. After eight days in the extractor the samples with the mesofauna were removed for proper counting on the stereoscope. Moisture, group richness and abundance of individuals were evaluated. The results showed that soil moisture favored the richness of the edaphic mesofauna. Extract and Cabrio® Top compared to water increased the richness of faunal groups, but water presented higher abundance of specimens. However, all evaluated variables did not show significant variability between treatments. Therefore, Macuco bean extract and Cabrio® Top maintained soil quality without imbalancing the edaphic mesofauna.*

Keywords**— *Collemboli, Mites; Group wealth; Abundance of specimens.***

I. INTRODUCTION

The use of pesticides in Brazil was regulated by Decree 24,114 in 1934 and was registered with the Ministry of Agriculture. From 1990, with Law 7802/89 (regulated by Decree No. 4.074 / 02), it became mandatory the environmental assessment, for registration and marketing, or what is mandatory for most registrations based on organochlorines with loss. of validity (IBAMA, 2009). Currently, the registration of pesticides begins with the Ministry of Agriculture, Livestock and Supply - Map, followed by the Ministry of Health - MS and ends at the Ministry of Environment - MMA (BRESSAN; SOUZA, 2018).

Borsoi et al. (2014) states that soils of agricultural use, showing changes in mesofauna, in number of species, when compared to virgin soils, show changes in the soil, mainly in the middle of the use of pesticides, causing changes in their structure and leaving purposes the mortality of species and the proliferation of other resistances. The same author states that this disturbance disperses the organisms and facilitates the arrival of hosts, being necessary or used for another pesticide, interfering with the availability of food waste and weakening the natural regeneration of the soil.

As plants, they may offer natural elements, but they are potentially toxic to some organisms, where these may be an alternative option or replace pesticides with products of biological origin, given the environmental perspectives (JORGE, 2017).

Yam bean (Pachyrhizus spp.) Also known as jacatupé, is an atypical but adaptable horticulture that can produce up to 108 t ha^{-1} (SILVA et al. 2016). Its roots are edible and rich in proteins and minerals (VASCONCELOS, 2018), such as seeds and leaves that cause toxicity by containing a rotation in their composition (LEUNER et al. 2013), a natural inhibitor of mitochondrial complex I, a cell death (CATTEAU et al. 2013). Its seeds have been shown to be genotoxic and cytotoxic (ESTRELLA-PARRA et al. 2014) showing potentiality in disease

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control. Thus, even with all knowledge about its toxic properties, it is unknown or the effect that causes stability on the soil.

Among the bioindicators for assessing soil quality is an analysis of fauna diversity, which is considered to be most sensitive because it has rapid response to change, being a mesofauna used for testing, for using change for change and important for soil nutrient mineralization (CARVALHO, 2014). The colembolis and mites are part of the editorial mesofauna, are organisms expressive in quantities, which move through pores to soil, influence the transport of mineral and organic materials, and participate in chemical decomposition, contributing to nutrient cycling (OLIVEIRA FILHO; BARETTA, 2016).

Therefore, the aim of this study was to determine the effect Cabrio® Top fungicides and yam bean extract have on soil mesofauna.

II. MATERIAL AND METHOD

2.1 Area of study

The experiments were conducted in a grassy area, with no history of pesticide use, of the National Institute of Amazonian Research - INPA (03 ° 05 '29' 'S and 59 ° 59' 34 " W), in Manaus - AM, with further analysis in the Institute's terrestrial invertebrate laboratory.

2.2 Treatments

1) Yam bean extract at 1: 1000 concentration, with ground and macerated seeds of P40 progeny for immediate application.

2) Cabrio® Top Fungicide (1: 250) and 3) negative control: water.

Twenty ml of the treatments were applied using a hand sprayer with a capacity of 500 ml (each jet = 1 ml).

2.3 Experimental Design

Fig. 1: Experimental structure in undergrowth area. Source: Guimarães, 2019.

Caption: 1 = Yam bean extract; 2 = Cabrio® Top; 3 = Water.

Pipes 100 mm in diameter were cut at a height of 15 cm, with 10 cm inserted into the ground and 5 cm free at the surface, with 50x50 cm spacing between blocks and plots (Figure 1). It was followed the completely randomized block design (DBC), containing three treatments and six repetitions, one barrel being the experimental unit.

2.4 Sample Collection

Soil samples were collected from 0-10 cm deep (Figure 2), where after four days of spraying, they were placed in plastic pots and taken to the laboratory, being properly weighed on a digital scale (error = 0.01 g) to obtaining fresh weight.

Fig. 2: Samples taken for laboratory analysis. Source: Guimarães, 2019.

2.5 Extraction of mesofauna from soil samples

The modified Berlese-Tullgren method (OLIVEIRA et al. 1999) was used for the extraction of mesofauna, which consists of a funnel lined with nylon mesh (2 mm) to hold the soil. glass (100 ml) with alcohol (92.8 °) for collection. The samples were placed in a cabinet equipped with a funnel socket structure and parallel incandescent light bulbs (40 W) (Figure 3). The lamps were switched on after 24 hours to avoid burning the mesofauna contained in the surface, keeping them on for eight days.

The heat supplied by the lamp dries the soil and forces the mesofauna to move downwards into the glass container with alcohol. The containers were removed from the extractor and boiled so as not to fluctuate the extracted mesofauna, thus facilitating the counting, being identified with the place, date and treatment, for proper counting on the stereoscope (40 times increase). The soils contained in the funnels were weighed again to obtain dry weight.

Figure 3 - Mesofauna extraction apparatus from soil samples by the Berlese-Tullgren funnel method.
Source: Guimarães, 2019.

2.6 Soil Moisture Content

Soil moisture was calculated using the equation:

$U = ((Pf - Ps) / Ps) . 100$

Where U = soil moisture content; Pf = fresh weight; Ps = dry weight. The unit of soil moisture content is given as a percentage.

2.7 Mesofauna Count

Alcohol samples (with mesofauna) were poured into 10 cm diameter Petri dishes. Their morphology was identified up to the Taxonomic Order level, the Collembola Order specimens were identified at the genus level. With this count was calculated the abundance (number of individuals) and the richness of the treatments, which was based on the number of groups (Order / Subclass) present in each treatment.

2.8 Statistical Analysis

Data were submitted to the Kruskal-Wallis test. Analyzes were performed using the SAS 9.4 PROC NPAR1WAY procedure (SAS Institute Inc, Cary, NC).

III. RESULTS AND DISCUSSION

We found 1081 individuals within 11 taxonomic groups belonging to the Aracnhida, Hexapoda and Insecta classes. Of the total specimens, 387 were collected from water-treated soil, followed by 367 yam bean extract and 327 with Cabrio® Top (Table 1). Based on the results, it was observed that there was no significant difference in all variables analyzed between treatments (Table 2).

Soil samples with bean extract showed greater genus diversity and greater abundance of specimens in the Collembola Order (Table 1). Studies show that yam bean extracts have piscicidal action (CROMBIE et al. 1998), insecticide, acaricide (BÉJAR et al. 2000), viricide (PHRUTIVORAPONGKUL et al. 2002), fungicide (BARRERA-NECHA et al. 2004) and bactericidal (MARTINS; BENAVENTE, 2018).

Despite its toxicity, yam bean favored a diverse environment in faunal groups (Table 1). Even though no significant difference in group richness was detected between the treatments (Table 2), further studies of the substances released by the extract, which provided the edaphic fauna with possible dietary variability, are recommended.

Cabrio® Top was the treatment that presented the lowest number of collemboli with 33 specimens, but obtained richness in the total mesofauna (Table 1). Collemboli feed on hyphae of fungi, bacteria and dead plant material (PAUL; NONGMAITHEM, 2011; SILVA et al. 2014). By feeding on old hyphae, they help in the growth of fungi (RUSEK, 1998), that is, it creates a stable environment where new fungi reproduce, increasing the availability of food for colemboli that control the soil fungal biomass (BERUDE et al. 2015). Cabrio® Top is a systemic double action and environmental hazard class II fungicide (BASF, 2019), its effect did not harm the richness of the mesofauna, but reduced the abundance of specimens.

The water control showed greater abundance of specimens in the total mesofauna, but reduced its richness in faunal groups. However, the absence of significant variability between treatments (Table 2) shows that yam bean extracts and Cabrio® Top fungicide are promising for disease control without harming edaphic mesofauna.

Tab. 1: Number of specimens extracted from soil samples in grassy area.

Class	Order/Subclass	Genre	Water	Cabrio® Top	Yam bean
ARACHNIDA	*Acari* (others)		318	268	290
	Acari Oribatida		12	8	8
HEXAPODA	*Collembola*	*Entomobrya* sp. 1	19	21	26
		Entomobrya sp. 2	14	3	5
		Lepidocyrtus	2	3	9
		Folsomides	11	4	5
		Proisotoma	0	0	1
		Sphaeridia	0	2	1
INSECTA	*Coleoptera im.*		1	0	0
	Diptera		0	2	0
	Diptera im.		0	1	0
	Homoptera		3	1	4
	Hemiptera ad.		0	0	2
	Hymenoptera		5	7	7
	Psocoptera		2	5	6
	Thysanoptera		0	2	3
Total			387	327	367

Source: Authors, 2019.

The Acari group prevailed in all treatments, with 83.62% of the total number of individuals (Table 1), being the most abundant of the soil mesofauna, reaching 84.7% in pastures (MORAIS et al. 2013). The Collembola Order had a participation of 11.65% of the total of individuals (Table 1), with lower representation when compared to Acaris, corroborating the results found by Chelinho et al. (2014); Pinto (2018).

Of the total acarofauna, the water treatment promoted the largest abundance of individuals with 36.5%, followed by 32.96% yam bean extracts and 30.53% by Cabrio® Top (Table 1). Since there was no significant difference between treatments (Table 2), the fungicide and the extract maintained the soil quality. The edaphic mesofauna, in particular the mite population abundance, is one of the main indicators of soil disturbance (CARVALHO, 2014), acting as predators and important in nutrient cycling, in addition to improving soil physical attributes such as porosity and aeration (PEREIRA et al. 2012).

Tab. 2: Kruskal-Wallis test for comparison of variables between treatments.

Source of Variation		Wilcoxon Scores			Kruskal-Wallis	
		Water	Cabrio® Top	Extract	X^2	P
Fresh Weight (g)		10,33	10,33	7,83	0,88	0,64
Dry Weight (g)		10,33	10,50	7,67	1,06	0,59
humidity (%)		8,25	10,58	9,67	0,58	0,75
Abundance		8,83	9,00	10,67	0,43	0,81
Group Wealth		8,17	10,17	10,17	0,56	0,76
Order *Acari*	*Acari* (others)	8,83	9,33	10,33	0,25	0,88
	Acari Oribatida	10,83	8,17	9,50	0,82	0,66
	Acari total	9,00	9,17	10,33	0,22	0,89
Order *Collembola*	*Entomobrya sp. 1*	9,33	7,67	11,50	1,59	0,45
	Entomobrya sp. 2	12,67	7,50	8,33	3,70	0,16
	Folsomides	10,00	9,33	9,17	0,12	0,94
	Lepidocyrtus	8,17	8,67	11,67	1,82	0,40
	Proisotoma	9,00	9,00	10,50	2,00	0,37
	Sphaeridia	8,70	10,08	9,92	1,07	0,59
	Collembola total	10,67	7,00	10,83	1,98	0,37
Class *INSECTA*	*Coleoptera im.*	10,50	9,00	9,00	2,00	0,37
	Diptera total	8,50	11,50	8,50	4,24	0,12
	Diptera	8,50	11,50	8,50	4,24	0,12
	Diptera im.	9,00	10,50	9,00	2,00	0,37
	Homoptera	9,83	8,33	10,33	0,73	0,69
	Hemiptera ad.	9,00	9,00	10,50	2,00	0,37
	Hymenoptera	9,00	9,92	9,58	0,10	0,95
	Psocoptera	7,50	10,00	11,00	1,56	0,46
	Thysanoptera	8,00	9,67	10,83	2,02	0,36

Source: Authors, 2019

The moisture content ranged from 9.4 to 19.3%, with an average of 13.6% for water treatment, 14.2% for extract and 14.7% for Cabrio® Top. Soil moisture favored the richness of edaphic mesofauna groups, although not presenting statistically significant difference in moisture between treatments (Table 2). Souto et al. (2008) states that the abundance of mites in relation to the colemboli is related to the ability of mites to support different moisture levels in the soil.

In this work, no significant correlation was found between the total of collemboli with the mites, but when correlating the humidity with the mesofauna groups, a significant difference was detected only for Diptera im. ($r = 0.47$; $p = <0.05$).

IV. CONCLUSION

Yam bean extracts (1: 1000) and Cabrio® Top (1: 250) provide faunal diversity. Therefore, they do not unbalance the edaphic mesofauna and do not reduce soil quality.

Therefore, further studies are recommended based on a greater number of repetitions and different dosages, in order to know if different materials have similar results or to find new conditions that favor soil restructuring, with a view to pest control and better production.

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