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Original Paper

Phytosociological survey of weeds in cocoa plantation

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Abstract

The cocoa crop is an important source of income for many farmers in the region of Altamira-PA, and other neighboring regions. Cocoa production has great economic importance in this region and in much of the state of Pará. The objective of this study was to determine which species of weeds affect the culture of cocoa in Princesa do Xingu agricultural village, Altamira-PA. This survey followed a few steps: collecting, counting, drying and species identification. The phytosociological parameters frequency, density, abundance, relative frequency, relative density, relative abundance and the Importance Value Index (I.V.I.) were used to analyze the data. A total of 13 botanical families were identified, distributed in 27 species and 691 individuals. Families who registered highest number of individuals were: Cyperaceae (130), Poaceae (95), Fabaceae (89), Rubiaceae (89), Lamiaceae (66) and Verbenaceae (60), followed by Amaranthaceae (56), Plantaginaceae (48) and Asteraceae (44). The species *Calopogonium mucunoides* Std., *Scoparia dulcis* L., had occurred in 5 squares. Among the species, which showed the highest levels of importance value were: *Alternanthera brasiliana* (L.) Kuntze. (25.90%), *Pycreus polystachyos* (Rottb.) P. Beauv. (24.29%), *Hyptis atrorubens* Poit. (21.41%), *Stachytarpheta cayennensis* (Rich.) Vahl. (18.82%), *Scoparia dulcis* L. (18.62%) and *Calopogonium mucunoides* Std. (16.60%).

Key-words: Competition. Weed science. *Theobroma cacao* L.

Introduction

In the Transamazonian region, as in the rest of Brazil, there are few research works aimed at identifying plants that compete for water, light, nutrients and CO_2 with the cocoa crop (*Theobroma cacao L.*), to know the main weed species that integrate the weed community in this crop and understand their dynamics is very important to better plan the management of these weeds, and thus maximize their control, especially for this crop that is the base of the economy of many agricultural units in Altamira and neighboring regions.

Agricultural crops and weeds have demands for environmental resources, such as light, gas, nutrients and water, which often become scarce. In this way, it is established that competition and agricultural crops are subject to a number of environmental factors that influence growth, development and economic productivity. The interference of weed plants leads to reductions in yields (Santana, 2008). It is estimated that losses caused to agricultural crops by weed interference in Brazil are around 20-30% (Lorenzi, 2014).

According to Silva Neto (2013), the period of greatest competition of weeds with the cocoa tree occurs during the months of low rainfall precipitance, and weed control aims to reduce competition by factors of the environment exerted by the invaders on the cocoa tree crop, as well as facilitating other cropping practices, especially fertilization and harvesting.

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The methodology most used in the floristic recognition of agricultural areas or not, is the phytosociological study, which involves the interrelationships of species in a given locality and time (Maciel et al., 2010). The analysis or phytosociological study is an important tool to know, monitor and understand which weed species are present in the assessed area and in what form they are distributed, and according to Huqi et al. (2010), through these analyzes can be formulated strategies and management techniques, aiming to adopt integrated control practices, where the main objective is not to eliminate all weeds, but to keep them within an economical and manageable limit.

Moreira et al. (2013), emphasize that the study of plant communities or phytosociological studies compare weed populations at a given moment, considering the consequences of the management application; These studies aim to evaluate the weed community of a given crop, compare organic and conventional crops of production systems and to evaluate the effect of green manures and intercropping systems.

Considering the few literature available on cocoa crop weed phytosociology, in Altamira, which is part of the Transamazon and Xingu region, the objective of this research was to identify and quantify the weed species that affect the cocoa cultivation at Princesa do Xingu agricultural village.

Material and Methods

The data were collected in September 2013, in Princesa do Xingu agricultural village located in the Xingu region, in the city of Altamira - PA (latitude 03º10'33,2 "S and longitude 52º24'31,6"W). The climate of the region according to *Köppen* is characterized as equatorial type Am and Wm, with average annual temperatures of 26º C and annual precipitation, around 1,680 mm, with rainy season concentrated between the months of January and May. The soil of the property is characterized as Yellow Distrophic Latosol (Pará, 2011). The area chosen for the survey has a characteristic flat relief, and previously the vegetation was composed by pasture (*Urochloa brizantha*).

The phytosociological survey was carried out in 0.5 ha of a 3-year-old cocoa crop grown under 3 x 3 m spacing. The weeds were collected through the square inventory method, which consists of the use of a square of wood, with an area of 1 m2, randomly launched zigzag walking through the site (Erasmo et al., 2004). The frame was thrown 5 times, totaling an area of 5 m2. The weed samples were collected at the demarcated sites, separated by species, stored in plastic bags and sent to the Soil Laboratory of the Agronomic Engineering College of the Federal University of Pará, Altamira Campus, where they were identified, counted and dried in an oven at a temperature of 60º to 70º C until reaching constant weight (Martins-da-Silva, 2002). To identify the species, we used as literature Lorenzi (2008); Lorenzi (2008); Souza and Lorenzi (2014).

The quantitative analysis of the invasive species present in the evaluation area was made based on the following phytosociological parameters: frequency that expresses the intensity of occurrence of a species by areas (%); density, referring to the number of plants per unit area in each species (plants / m2) and abundance, which informs the concentration of the species at certain points. The relative frequency, relative density and relative abundance were also calculated, which indicate the Importance Value Index (I.V.I), which establishes an integration parameter of the partial variables, in order to combine them in a single and simple expression, exposing the relative importance of each species (Inoue et al., 2012). The phytosociological indexes were calculated according to Brandão et al. (1998).

Results

In this survey, 691 individuals belonging to 27 species were identified and distributed in 13 botanical families. Among the species collected, 59% belong to the class of dicotyledons and 41% to the monocotyledons.

The Cyperaceae, Fabaceae, Poaceae and Rubiaceae families recorded the highest numbers of species, six, four and three for the last two, respectively, while the smaller numbers of species were concentrated in the Amaranthaceae, Brasicaceae, Euphorbiaceae, Lamiaceae, Malvaceae, Plantaginaceae and Onagraceae families, both with only one species (Table 1).

The 10 species that concentrated the largest amount of individuals were: *P. polystachyos* (72), *H. atrorubens* (66), *A. brasiliana* (56), *S. cayennensis* (54), *S. dulcis* (48), *D. insularis* (46), *S. verticillata* (45), *C. mucunoides* (38), *C. maximilianii* and *D. bicornis* (29).

The species *C. mucunoides* and *S. dulcis* were present in all plots, both with a relative frequency of 8.93%, whereas *H. atrorubens* and *S. cayennensis* occurred in 4 plots and had a relative frequency of 7.14% (Table 2).

Table 1. Weed species and their respective families identified in the cocoa crop, in the Princesa do Xingu agricultural village, Altamira - PA.

FAMILY	SPECIES	N^{O} OF INDIVIDUALS
AMARANTHACEAE	*Alternanthera brasiliana* (L.) Kuntze	56
ASTERACEAE	*Acanthospermum australe* (Loefl.) Kuntze	12
	Chromolaena maximilianii (Schrad.) R. M. King & H. Rob.	32
BRASICACEAE	*Cleome affinis* DC.	01
CYPERACEAE	*Fimbristylis dichotoma* (L.) Vahl	17
	Cyperus difformis L.	12
	Pycreus polystachyos (Rottb.) P. Beauv.	72
	Rhynchospora nervosa (Vahl) Boeck.	04
	Bulbostylis sp.	09
	Fimbristy*lis* sp.	16
EUPHORBIACEAE	*Sebastiania corniculata* (Vahl) Müll. Arg.	09
FABACEAE	*Zornia* reti*culata* Sm.	10
	Calopogonium mucunoides Desv.	38
	Desmodium barbatum (L.) Benth.	15
	Desmodium sp.	26
LAMIACEAE	*Hyptis atrorubens* Poit.	66
MALVACEAE	*Waltheria indica* L.	03
ONAGRACEAE	*Ludwigia tomentosa* (Cambess.) H. Hara	01
PLANTAGINACEAE	*Scoparia dulcis* L.	48
POACEAE	*Digitaria insularis* (L.) Fedde	46
	Digitaria bicornis (Lam.) Roem. & Schult.	29
	Eragrostis plana Nees	20
RUBIACEAE	*Spermacoce verticillata* L.	45
	Spermacoce capitata Ruiz & Pav.	28
	Spermacoce sp.	16
VERBENACEAE	*Stachytarpheta cayennensis* (Rich.) Vahl	54
	Lantana camara L.	06
Total		691

The most abundant species were *A. brasiliana*, *P. polystachyos*, *Desmodium* sp., E. *plana* and *H. atrorubens*, (Table 2), belonging respectively to the Amaranthaceae, Cyperaceae, Fabacea, Poaceae and Lamiaceae families.

The species with the highest importance value index (IVI) were *A. brasiliana*, *P. polystachyos*, *H. atrorubens*, *S. cayennensis*, *S. dulcis* and *C. mucunoides* (Figure 1), belonging respectively to the Amaranthaceae, Cyperaceae, Lamiaceae, Verbenaceae, Plantaginaceae and Fabaceae families.

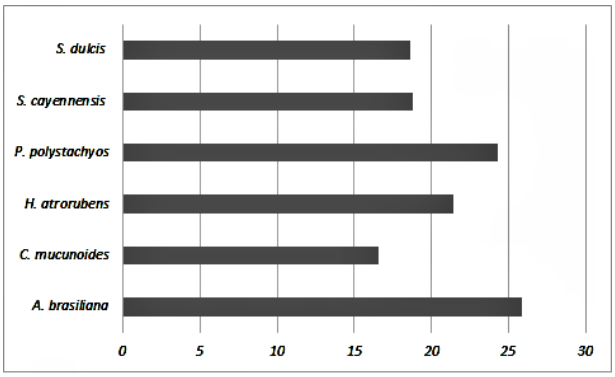

Fig. 1. Importance Value Index (%) of the weed species in the *Princesa do Xingu* agricultural village.

Table 2. Phytosociological parameters of weeds incident on cocoa crop, in the Princesa do Xingu agricultural village, Altamira-PA.

Species	Abun.	Den.	Fre.	R.A.	R.D.	R.F.	I.V.I.
A. australe	12,00	2,40	0,20	3,43	1,74	1,79	6,95
A. brasiliana	56,00	11,20	0,20	16,1	8,10	1,79	25,90
Bulbostylis sp.	9,00	1,80	0,20	2,57	1,30	1,79	5,66
C. mucunoides	7,60	7,60	1,00	2,17	5,50	8,93	16,60
C. maximilianii	16,00	6,40	0,40	4,58	4,63	3,57	12,78
C. affinis	1,00	0,20	0,20	0,29	0,14	1,79	2,22
C. differmis	12,00	2,40	0,20	3,43	1,74	1,79	6,95
Desmodium sp.	26,00	5,20	0,20	7,43	3,76	1,79	12,98
D. barbatum	7,50	3,00	0,40	2,14	2,17	3,57	7,89
D. bicornis	9,67	5,80	0,60	2,76	4,20	5,36	12,32
D. insularis	15,33	9,20	0,60	4,38	6,66	5,36	16,40
E. plana	20,00	4,00	0,20	5,72	2,89	1,79	10,40
Fimbristylis sp.	16,00	3,20	0,20	4,58	2,32	1,79	8,68
F. dichotoma	5,67	3,40	0,60	1,62	2,46	5,36	9,44
H. atrorubens	16,50	13,20	0,80	4,72	9,55	7,14	21,41
L. camara	6,00	1,20	0,20	1,72	0,87	1,79	4,37
L. tomentosa	1,00	0,20	0,20	0,29	0,14	1,79	2,22
P. polystachyos	36,00	14,40	0,40	10,29	10,42	3,57	24,29
R. nervosa	4,00	0,80	0,20	1,14	0,58	1,79	3,51
S. dulcis	9,60	9,60	1,00	2,75	6,95	8,93	18,62
S. corniculata	9,00	1,80	0,20	2,57	1,30	1,79	5,66
Spermacoce sp.	8,00	3,20	0,40	2,29	2,32	3,57	8,17
S. capitata.	9,33	5,60	0,60	2,67	4,05	5,36	12,08
S. verticillata	15,00	9,00	0,60	4,29	6,51	5,36	16,16
S. cayennensis	13,50	10,80	0,80	3,86	7,81	7,14	18,82
W. indica	3,00	0,60	0,20	0,86	0,43	1,79	3,08
Z. reticulata	5,00	2,00	0,40	1,43	1,45	3,57	6,45
Total	349,70	138,20	11,20	100	100	100	300

Abun.: Abundance; Den.: Density; Freq.: Frequency; R.A.: Relative Abundance; R.D.: Relative Density; R.F.: Relative Frequency; I.V.I.: Importance Value Index.

Discussions

The 27 weed species and 13 botanical families identified in this survey were similar to those reported by Silva Neto et al. (2007) in *Medicilândia*, neighboring city of Altamira, 23 species and 11 families, and also to the 30 species described by Silva Neto et al. (2009) in areas cultivated with cocoa in agroforestry systems, in four cities of the Transamazon region.

The highest number of species belonging to the class of dicotyledons, 59%, was also observed by Albertino et al. (2004), in studies on the floristic composition of *guaraná* (*Paullinia cupana*) in the state of Amazonas, and by Souza et al. (2003), in *cupuaçu* tree (*Theobroma grandiflorum* (Willd. ex Spreng.) Schum.) and *pupunha* (*Bactris gasipaes*) palm agroecosystems in Amazonas.

The Cyperaceae (6), Fabaceae (4), Poaceae (3) and Rubiaceae (3) families registered larger numbers of species in this study, amount indicated in parentheses, this result is similar to that found by Marques et al. (2010) for cowpea (*Vigna unguiculata*) cultivated in the state of Maranhão, Cyperaceae (7), Fabaceae (7), Poaceae (6), and Rubiaceae (4). Whereas, in the study of the floristic composition of weeds in pastures in the city of Parintins state of Amazonas, Galvão *et al*. (2010), found that the most important families in number of species were Cyperaceae (8) and Rubiaceae (4).

The species *C mucunoides* and *S. dulcis* were predominant in the evaluation area, other species with high relative frequency were *S. cayennensis, S. verticillata,* Souza et al. (2011), also observed that the species *S. cayennensis and S. verticilata* occurred with high frequency in pastures of three agricultural properties in the Transamazon region.

The most abundant species were *A. brasiliana, P. polystachyos, Desmodium* sp., *E. plana* and *H. atrorubens*, however Silva Neto et al. (2009), point

out that guineagrass (*Panicum maximum Jacq*) was the most abundant species in the cocoa crop in four cities of the Transamazonian region.

The species *A. brasiliana, P. polystachyos, H. atrorubens, S. cayennensis, S. dulcis* and *C. mucunoides*, of the families, Amaranthaceae, Cyperaceae, Lamiaceae, Verbenaceae, Plantaginaceae and Fabaceae had the highest I.V.I, corroborating with data from Avila et al. (2012), in *conilon* coffee cultivation in Paragominas - PA, species of the Amaranthaceae family presented the highest I.V.I ..

Conclusions

For the region of study, the family with the highest representation was Cyperaceae. The most important species in the evaluation period were *A. brasiliana, P. polystachyos.*

Conflict of interest: All authors declare no conflict of interest.

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