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Weed nutrient content in commercial orange orchards in the region of Manaus, Amazonas

Teor de nutrientes em plantas daninhas de pomares de laranjeiras da região de Manaus, Amazonas

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ABSTRACT: Weeds compete for nutrients causing productivity losses with crops, so the quantification of nutrients in these plants can indicate their nutrient absorption efficiency. In this research we aim to identify weed species representative of three commercial orange orchards (*Citrus sinensis* L.) in the region of Manaus (AM), and to determine their potential for nutrient absorption. A survey of the floristic composition of orchards was carried out from August to October in 2019, and the phytosociological indicators of species were identified. The main species were selected according to the Importance Value Index (IVI). Weeds and *C. sinensis* leaves samples were analyzed to obtain nutrient contents. Weeds showed competitive potential in commercial orange orchards, once they had a high nutrient content in their dry matter. Weeds with greater amounts of nutrients were *Alternanthera Ficoidea* (L.) P. Beauv. (N, K, Mg, Cu, Mn and Zn), *Commelina benghalensis* L. (P, S and Fe), *Pseudelephantopus spiralis* (Less.) Cronquist (N, P, K, Mg, Fe and Zn), *Acalypha arvensis* Poepp. (P and Ca), *Cyperus diffusus* Vahl (Fe and Mn) and *Stachytarpheta cayennensis* (Rich.) Vahl (Mg and Zn).

Keywords: *Citrus sinensis* L.; Competition; Mineral nutrition; Plant communities.

RESUMO: As plantas daninhas competem por nutrientes com as culturas causando perda de produtividade, por isso a quantificação de nutrientes nestas plantas indica a eficiência de absorção. Nesse sentido, objetiva-se com esse trabalho identificar espécies de plantas daninhas representativas de três pomares comerciais de laranjeira (*Citrus sinensis* L.) da região metropolitana de Manaus (AM), e determinar seus potenciais de absorção de nutrientes. O levantamento da composição florística dos pomares foi realizado entre os meses de agosto e outubro de 2019, e os indicadores fitossociológicos das espécies foram calculados. As espécies representativas foram selecionadas de acordo com o Índice de Valor de Importância (IVI). As amostras de folhas das plantas daninhas e de *C. Sinensis* foram analisadas para obtenção dos teores de nutrientes. As plantas daninhas foram mais eficientes em absorver nutrientes e mostraram potencial competitivo em pomares comerciais de laranjeiras, uma vez que tiveram elevados teores de nutrientes em suas folhas. As plantas daninhas com maiores quantidade de nutrientes foram *Alternanthera ficoidea* (L.) P. Beauv. (N, K, Mg, Cu, Mn e Zn), *Commelina benghalensis* L. (P, S e Fe), *Pseudelephantopus spiralis* (Less.) Cronquist (N, P, K, Mg, Fe e Zn), *Acalypha arvensis* Poepp. (P e Ca), *Cyperus diffusus* Vahl (Fe e Mn) e *Stachytarpheta cayennensis* (Rich.) Vahl (Mg e Zn).

Palavras-chave: *Citrus sinensis* L.; Comunidade infestante; Competição; Nutrição mineral.

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INTRODUCTION

Citrus production is one of the most important agricultural activities in Brazil and has grown in the Amazon region (Pinheiro *et al.*, 2019). The favorable soil and climate conditions for the establishment of citrus farming (Carvalho *et al.*, 2015) also favor the growth of weeds, which interferes with production and causes productivity drops of up to 35% (Gonçalves *et al.*, 2018).

The presence of weeds in orchards is one of the main concerns of farmers (Nolla *et al.*, 2018) due to the competitive advantage over the main crop. The interference of these plants causes direct and indirect damage (Gonçalves *et al.*, 2018) as they have mechanisms that ensure survival in environments under constant disturbances (Concenço *et al.*, 2013).

The degree of importance of species belonging to weed communities is determined by the adoption of phytosociological indices, which compare the species that occur in a given community (Concenço *et al.*, 2013). Variables such as density, species response curve to fertilization, relative emergence time and resource availability interact to determine whether the soil fertility of an area will increase, decrease or have no effect on the yield of crop in competition with weeds (Little *et al.*, 2021). These comparative studies are important to determine the nutrient absorption potential of each species and infer its competitive ability (Carvalho *et al.*, 2014).

Studies on the competitive ability (CA) of weeds in orange trees are still few when compared to crops such as coffee (*Coffea arabica*), guarana (*Paullinia cupana*), soybean (*Glycine max*) and sugarcane (*Saccharum officinarum*) (Fialho *et al.*, 2012; Fontes and Nascimento Filho, 2013; Pitelli, 2014). For the metropolitan region of Manaus, it is known that the critical period of weed interference in orange orchards occurs between the months of October and May (Monteiro, 2011; Gonçalves *et al.*, 2014), which already helps the producer in the integrated management of this vegetation. However, when carrying out a survey of weeds and studying the nutrient content in their leaves, we can obtain relevant results for both integrated plant and soil fertility management.

In this research we aim to identify the main species of weeds in the orchards through the floristic and phytosociological composition, and to determine the potential of these plants to accumulate nutrients compared to orange trees.

2 MATERIALS AND METHODS

2.1 STUDY AREAS

The study was carried out between August and October 2019 in three commercial orange orchards in the metropolitan region of Manaus: Santa Rosa (SR), FMI Citrus (FMI) and Panorama (PN) farms.

The Köppen classification (Alvares *et al.*, 2013) indicates that the climate of the region is of type Af, rainforest, with constant high temperature, average values of 23,5ºC and 31,2ºC, and rainfall around 2.200 mm year^{1}.

The fertilizer management was carried out before oranges trees flowered (February and March), with surface application of chemical fertilizers. Weeds were controlled during the interference period in the region (October to May). In the SR farm, integrated management was carried out with the use of herbicides and controlled with a manual brush cutter. On the FMI farm, the use of herbicides and the control with ecological brush cutter between rows were adopted. On the PN farm, the use of herbicides and manual brush cutter were adopted as a control method.

Chemical and textural class of soil analyses show that orchards had its acidity and fertilization corrected before the sampling period (Table 1) even though they are characterized as acidic soils, with low SB, CEC and with corrected V%. However, soil correction did not reach base saturation for citrus in the region (60%) (Moreira *et al.*, 2008).

Table 1. Chemical attributes and textural class of soils at the farms

Farms	pH	M.O.[1]	Al^{3+}	H+Al[2]	SB[3]	T[4]	V[5]	m[6]	Textural class
	H_2O	g kg^{-1}	cmol$_c$ dm^{-3}				%		
SR	5.03	28.76	0.29	4.46	1.63	6.08	26.74	15.14	Sandy clay loam
FMI	5.84	44.78	0	4.60	4.48	9.08	49.30	0	Clay
PN	5.87	20.76	0	3.66	1.75	5.41	32.35	0	Sandy loam

[1]Organic matter, [2]Potential acidity, [3]Sum of bases, [4]Total CEC, [5]Base saturation, [6]Al saturation

2.2 FLORISTIC AND PHYTOSOCIOLOGY COMPOSITION OF WEEDS

Weed phytosociology was carried out according to the square inventory method (Braun-Blanquet, 1979) in which the sample rectangle (0.12 m²) was launched 20 times randomly between rows, sampling 2.4 m² in each farm. Weeds in the square were counted, identified and dried to obtain the dry matter.

Relative Density (RD), Relative Frequency (RF), Relative Abundance (RA), Importance Value Index (IVI) and Sorensen Area Similarity Index (IS) were obtained using formulas proposed by Mueller-Dombois and Ellemberg (1974). The dendrogram to demonstrate the similarity between areas was obtained by the unweighted pair group method with arithmetic mean (UPGMA).

The criteria for the selection of the 12 main species of the orchard was the IVI. IVI is used as an importance valuation criterion for gathering information from phytosociological parameters (RD, RF and RA) and to indicate the relationship between species in a given area (Sena *et al.*, 2019).

2.3 NUTRITIONAL ASSESSMENT OF WEEDS AND C. SINENSIS IN ORCHARDS

C. sinensis samples were collected from 20 orange trees in each farm according to the methodology proposed by Quaggio *et al.* (2005). Leaves were washed with neutral detergent, rinsed and dried for 72 hours to obtain the dry matter.

The dry matter of weeds and *C. sinensis* were crushed, divided into triplicate samples, and sent for chemical analysis of plant tissues at the Laboratory of Soils and Plants (LASP) of "Embrapa Amazônia Ocidental".

The results by Dias *et al.* (2013) were adopted as the critical range of nutrients in C. sinensis for the region, which indicates the interval of greater and lesser nutrient content for orange trees and weeds.

2.4 TREATMENTS AND EXPERIMENTAL DESIGN

The nutrient contents of plants were submitted to analysis of variance and comparison of means by the Scott Knott test at 5% probability. The experimental design used was randomized blocks (RBD). Treatments were the representative species and C. sinensis from each farm.

The predominant species in the SR farm were *Alternanthera ficoidea* (L.) P. Beauv, *Commelina benghalensis* L, *Digitaria insularis* (L.) Mez ex Ekman, *Urochloa eminii* (Mez) Davidse and *Urochloa* *mutica* (Forssk.) T. Q. Nguyen. In the FMI farm, the predominant species were *Eragrostis ciliaris* (L.) R. Br., Pseudelephantopus spiralis (Less.) Cronquist and *Urochloa brizantha* (A. Rich.) R. D. Webster. In the PN farm, the predominant species were *Acalypha arvensis* Poepp., *Commelina erecta* L., *Cyperus Diffusus* Vahl and *Stachytarpheta cayennensis* (Rich.) Vahl.

3 RESULTS AND DISCUSSION

3.1 FLORISTIC AND PHYTOSOCIOLOGY COMPOSITION OF WEEDS

The highest species richness was found in the orchards of the SR farm (54%), followed by FMI (42.3%) and PN (38.4%). Monocots predominated with 54% of species, which reflects the representativeness of Poaceae (8) and Cyperaceae (4) families in the areas (Table 2). These results corroborate those obtained in phytosociological surveys on perennial crops in the Amazon region (Soares *et al.,* 2019; Monteiro, 2011; Damasceno, 2013; Gonçalves *et al.,* 2019).

Table 2. Families and species of weeds in commercial orange orchards in Manaus, Amazonas

(Continua)

Families	Species	Farms		
		SR	FMI	PN
Commelinaceae	*Commelina benghalensis* L.	X	-	X
	Commelina erecta L.	-	-	X
Cyperaceae	*Cyperus diffusus* Vahl	X	-	X
	Cyperus distans L. f.	-	-	X
	Cyperus ferax Rich	-	X	-
	Cyperus aggregatus var. *aggregatus*	X	-	-
Poaceae	*Urochloa brizantha* (A. Rich.) R. D. Webster	-	X	-
	Urochloa eminii (Mez) Davidse	X	X	-
	Urochloa mutica (Forssk.) T. Q. Nguyen	X	-	-
	Urochloa plantaginea (Link) R. D. Webster	X	-	-
	Digitaria horizontalis Willd.	X	-	-
	Digitaria insularis (L.) Mez ex Ekman	X	X	-
	Digitaria sanguinalis (L.) Scop.	X	-	-
	Eragrostis ciliaris (L.) R. Br.	-	X	-
Amaranthaceae	*Alternanthera ficoidea* (L.) P. Beauv.	X	-	-
Asteraceae	*Ageratum conyzoides* L.	X	-	-
	Bidens pilosa L.	X	-	-
	Pseudelephantopus spiralis (Less.) Cronquist	X	X	X
Cleomaceae	*Cleome affinis* DC.	-	-	X

(Conclusão)

Families	Species	Farms		
		SR	FMI	PN
Euphorbiaceae	*Acalypha arvensis* Poepp.	-	-	X
	Euphorbia hirta L.	-	X	-
	Euphorbia heterophylla L.	X	X	X
Fabaceae	*Calopogonium mucunoides* Desv.	-	X	-
	Mimosa pudica L.	-	-	X
Malvaceae	*Anisodontea capensis* (L.) D. M. Bates	-	X	-
Rubiaceae	*Spermacoce verticillata* L.	-	X	-
Verbenaceae	*Stachytarpheta cayennensis* (Rich.) Vahl	-	-	X
Total		14	11	10

There were similarities between the FMI and SR farms (0.400), and these two farms and PN (0.347) (Figure 1). Five species were common to SR and FMI (*C. diffusus*, *D. insularis*, *E. heterophylla*, *P. spiraris* and *U. uminii*), and four to SR and PN (*C. benghalensis, C. diffusus*, *E. heterophylla* and *P. spiralis*). The similarity between FMI and PN was basically the common species to the three farms (*C. diffusus*, *E. heterophylla* and *P. spiralis*). The similarity of species is related to the similarity between management systems and cultural practices (Inoue *et al.*, 2012) adopted in SR and FMI farms and the greatest richness of species found.

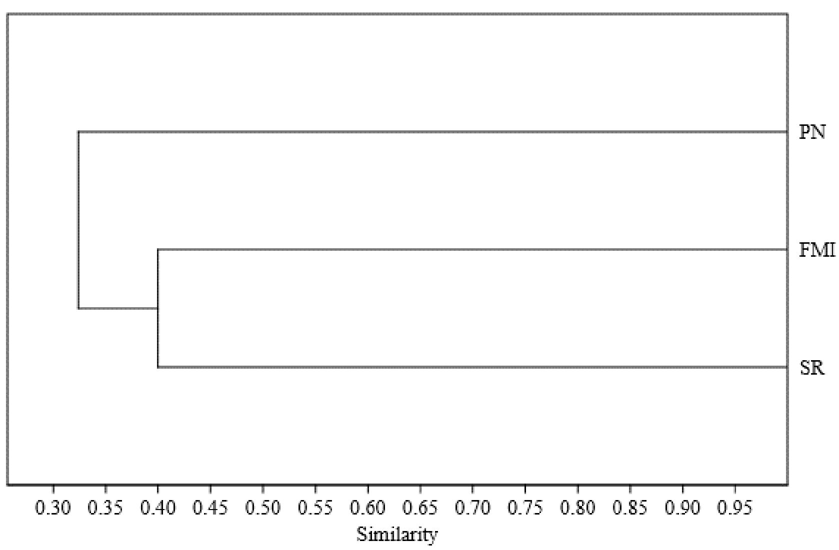

Figure 1. Sorensen Similarity Index among weeds in commercial orange orchards in Manaus, Amazonas

The main weeds were aggregated in the field (Table 3), which depend on the cover soil management system, crop and infesting species (Schaffrath *et al.*, 2007) and can influence suppression in the highest infestation points (Lopes *et al.*, 2020). The control management by ecological and manual brush cutter adopted in orchards allows plant remains to cover the soil, suppressing the development of less adapted species and allowing the aggregate emergence of species with greater potential for dispersion and adaptation.

Table 3. Distribution of the main weeds in commercial orange orchards in Manaus, Amazonas

Species	RD[1]	RF[2]	RA[3]	IVI[4]	Distribution
	%				
A. arvensis	6.80	9.09	8.82	24.70	Aggregate
A. ficoidea	19.24	18.42	7.67	45.34	Aggregate
C. benghalensis.	9.33	7.89	8.68	25.91	Aggregate
C. erecta	29.13	21.21	16.19	66.53	Aggregate
C. diffusus	33.01	15.15	25.69	73.85	Aggregate
D. insularis	8.74	20.63	3.82	33.19	Aggregate
P. spiralis	58.90	22.22	23.9	105.02	Aggregate
E. ciliares	6.47	1.59	36.76	44.82	Aggregate
S. cayennensis	8.74	15.15	6.80	30.69	Aggregate
U. brizantha	7.44	6.35	10.57	24.36	Aggregate
U. eminii	22.45	17.11	9.64	49.20	Aggregate
U. mutica	11.66	3.95	21.70	37.31	Aggregate

[1] Relative Density, [2] Relative Frequency, [3] Relative Abundance, [4] Importance Value Index

P. spiralis, *C. diffusus*, *C. erecta* and *U. eminii* had the highest IVI among plants under study. RD was the most relevant parameter for the high IVI of these species, which indicates the high percentage of these individuals in orchards (Table 3). The four species have in common the difficulty of control when it occurs in large amounts in a given area. *P. spiralis* develops in a wide humidity value and produces a thick cover that suffocates other weeds (Araújo *et al.*, 2011). *U. eminii* has rapid adaptation, so it is highly aggressive and competitive (Rodrigues *et al.*, 2020). *C. diffusus* and *C. erecta* are easily propagated by seeds and rhizomes, and by rooting fragments (Moreira; Bragança, 2010). The diversity and aggregate disposition of species in the three areas contribute to increase the competitive potential of the plants. The more diverse the weed community, the greater the likelihood that at least one species is highly competitive for soil nutrients (Little *et al.*, 2021).

3.2 NUTRIENT CONTENT OF WEEDS AND C. SINENSIS IN ORCHARDS

Weeds had more nutrients in their dry matter than orange trees leaves, except for Ca, which can indicate the high competitive potential of these plants (Table 4). Weed with the highest levels of nutrients in the SR farm were *A. ficoidea* (N, K, Mg and Zn) and *C. benghalensis* (N, P, S, Cu and Fe).

Table 4. Nutrient contents in the main weeds and orange trees at SR farm

(Continua)

Species	Macronutrients					
	N	P	K	Ca	Mg	S
	g kg^{-1}					
Critical range[1]	24-26	1.2-1.7	10-14	35-40	2-3	2-2.5
C. sinensis	30.82 b[2]	1.87 c	24.44 c	12.66 a	7.75 c	2.63 c
A. ficoidea	33.35 a	1.77 c	53.35 a	9.23 b	20.60 a	1.86 d

(Conclusão)

Species	Macronutrients					
	N	P	K	Ca	Mg	S
	g kg-1					
Critical range[1]	24-26	1.2-1.7	10-14	35-40	2-3	2-2.5
C. benghalensis	33.51 a	2.68 a	28.08 b	11.88 a	11.11 b	3.67 a
D. insularis	24.42 c	2.28 b	25.17 c	2.29 c	6.90 c	3.15 b
U. eminii	14.28 d	1.62 c	13.10 e	2.86 c	6.57 c	2.65 c
U. mutica	15.50 d	1.21 d	16.50 d	1.00 d	5.25 c	1.67 d
TNC[3]	151.88	11.43	160.64	39.92	58.18	15.63
% NCW[4]	79.71	83.64	84.76	68.29	86.68	83.17
	Micronutrients					
	Cu	**Fe**	**Mn**	**Zn**		
	mg kg-1					
Critical range	10-30	130-300	25-50	25-50		
C. sinensis	7.48 B	124.10 d	16.30 c	27.95 c		
A. ficoidea	10.49 a	268.61 c	20.27 a	54.13 a		
C. benghalensis	10.78 a	640.38 a	39.92 a	35.26 c		
D. insularis	7.60 b	163.76 d	48.08 a	30.47 c		
U. eminii	5.58 c	322.15 c	25.45 b	38.35 c		
U. mutica	5.72 c	460.12 b	35.12 a	43.00 b		
TNC	47.65	1979.12	185.14	229.16		
% NCW	84.30	93.73	91.20	87.80		

[1] Critical range of nutrients in *C. sinensis* in Amazonas (DIAS et al., 2013);

[2] Values followed by the same letter do not differ significantly according to the Scott-Knott test at 5% probability ($p \leq 0.05$);

[3] Total nutrient content in plants;

[4] Percentage of nutrients content in weeds.

A. ficoidea belongs to the genus Alternanthera, whose efficiency to accumulate N, P and K during the maturation period of the main crop is indicated by Mishra and Singh (2008) which has already caused crop production losses from 19% to 60% worldwide (Tanveer; Abdul, 2013). These results corroborate those obtained by Nadeem *et al.* (2018) and Pawar *et al.* (2022) in studies on interference with species of agricultural interest. *C. benghalensis* has fast and efficient response to nutrient absorption in a managed environment (Riar *et al.*, 2016). P and S levels increase, and K levels decrease in this plant when it grows in soil corrected with liming (Rodrigues *et al.*, 1995) which justifies the high levels of these nutrients in plant tissues. *C. benghalensis* and *A. ficoidea* had similar performance in the SR farm. The species had an average of 22% of nutrients higher in the orange orchards.

Except for Ca, more than 70% of the total nutrients were higher in weeds in the FMI farm (Table 5). C. sinensis had the highest Ca and S levels, however Ca levels in this farm were below the critical range (DIAS *et al.*, 2013). *P. spiralis* was the species with the highest efficiency accumulating nutrients in this farm (N, P, K, Mg, Fe and Zn) with an average absorption of 32%. The high frequency of plants in the area indicates the suppression of other weeds (Araújo *et al.*, 2011), which contributed to the good performance of this species in nutrient absorption.

Table 5. Nutrient contents in the main weeds and orange trees at FMI farm

Species	N	P	K	Ca	Mg	S
	Macronutrients (g kg^{-1})					
Critical range[1]	24-26	1.2-1.7	10-14	35-40	2-3	2-2.5
C. sinensis	26.20 b[2]	1.54 b	16.00 c	20.06 a	5.33 c	3.31 a
P. spiralis	28.14 a	2.74 a	32.95 a	10.35 b	12.08 a	1.93 b
E. ciliares	14.87 c	1.91 b	23.23 b	2.87 d	4.64 c	1.85 b
U. brizantha	10.91 d	1.71 b	15.35 c	3.85 c	8.52 b	3.25 a
TNC[3]	80.12	7.90	87.53	37.13	30.57	10.34
% NCW[4]	67.30	80.50	81.72	45.97	82.56	67.99

Species	Cu	Fe	Mn	Zn
	Micronutrients (mg kg^{-1})			
Critical range	10-30	130-300	25-50	25-50
C. sinensis	92.49 a	193.69 c	14.36 a	11.89 c
P. spiralis	21.18 b	864.10 a	17.94 a	55.70 a
E. ciliares	9.92 c	442.97 b	26.81 a	32.87 b
U. brizantha	5.48 d	346.60 b	22.23 a	16.31 c
TNC	129.07	1847.36	81.34	116.77
% NCW	28.34	89.52	82.35	89.82

[1] Critical range of nutrients in *C. sinensis* in Amazonas (DIAS et al., 2013);
[2] Values followed by the same letter do not differ significantly according to the Scott-Knott test at 5% probability ($p \leq 0.05$);
[3] Total nutrient content in plants;
[4] Percentage of nutrients content in weeds.

A. arvensis (P and Ca), *C. diffusus* (Fe and Mn) and *S. Cayennensis* (Mg and Zn) were the species with higher nutrients in the PN farm (Table 6). However, *C. sinensis* had the highest content of macronutrient (N, Ca and S).

Table 6. Nutrient contents in the main weeds and orange trees at PN farm

(Continua)

Species	N	P	K	Ca	Mg	S
	Macronutrients (g kg^{-1})					
Critical range[1]	24-26	1.2-1.7	10-14	35-40	2-3	2-2.5
C. sinensis	36.76 a[2]	1.45 e	7.88 e	11.61 a	3.12 c	2.30 a
A. arvensis	26.04 e	2.86 a	16.59 d	10.43 a	4.02 b	1.64 b
C. diffusus	30.88 c	2.27 c	24.86 b	1.97 d	2.54 d	1.35 c

Macronutrients						
Species	**N**	**P**	**K**	**Ca**	**Mg**	**S**
			g kg-1			
Critical range [1]	24-26	1.2-1.7	10-14	35-40	2-3	2-2.5
C. erecta	28.12 d	2.52 b	28.70 a	7.99 b	3.03 c	2.17 a
S. cayennensis	32.04 b	2.18 d	19.88 c	4.81 c	5.44 a	1.84 b
TNC[3]	153.84	11.28	97.91	36.81	18.15	9.30
% NCW[4]	76.10	87.14	91.95	68.46	82.81	75.27

Micronutrients				
Species	**Cu**	**Fe**	**Mn**	**Zn**
		mg kg-1		
Critical range	10-30	130-300	25-50	25-50
C. sinensis	18.30 a	90.47 d	13.17 d	15.53 e
A. arvensis	10.72 d	115.58 c	101.18 c	40.36 b
C. Diffusus	14.30 c	302.78 a	169.62 a	30.99 d
C. erecta	13.55 c	138.94 b	123.40 b	34.06 c
S. cayennensis	15.91 b	136.15 b	115.37 b	51.46 a
TNC	72.78	783.92	522.74	172.40
% NCW	74.86	88.46	97.48	90.99

[1] Critical range of nutrients in *C. sinensis* in Amazonas (DIAS et al., 2013);
[2] Values followed by the same letter do not differ significantly according to the Scott-Knott test at 5% probability ($p \leq 0.05$);
[3] Total nutrient content in plants;
[4] Percentage of nutrients content in weeds.

The high Fe and Mn levels in *C. diffusus* occur due to the high capacity of plants of this genus to concentrate them in leaves, while accumulating the other micronutrients in roots (Lans, 2018). *S. Cayennensis* is efficient for removing metals and micronutrients from the environment (Petelka *et al.*, 2019). Cyperaceas are used due to their ability to easily remove undesirable elements from the soil and waterway systems (Sundaramoorthy *et al.*, 2010; Casierra-Martínez *et al.*, 2017).

In general, weeds had a better performance than citrus in nutrient concentration in dry matter, especially those that are the most important targets of investments by producers (N, P and K). Several large-scale surveys of weed species indicate that the growth of certain species is particularly sensitive to N, P and K availability (Little *et al.*, 2021).

C. sinensis was efficient to accumulate Ca in the three farms due to the high demand of the crop for this nutrient during the fruit maturation period (Fu *et al.*, 2019) and N and S in the PN farm. However, we can say that weeds were also efficient accumulating Ca and perhaps competing with orange trees for soil resources, once Ca levels in orange trees were didn't reach the critical range recommended for the region and not significantly different from levels absorbed by *A. arvensis* (Table 6).

The effects of fertility treatments on the competition between weeds and the main crop vary according to the source of nutrients provided in fertilization (Little *et al.*, 2021). Orange trees in the SR farm had levels of macronutrients above the critical range, except Ca (Table 4). This suggests that liming didn't reach V% for citrus in the region (Table 1), and that the Ca:Mg ratio was not sufficient to meet the demand for these nutrients. The levels of nutrients in *C. sinensis* corroborate Gonçalves *et al.* (2019) for N, P, S and Fe in the SR farm; N, Ca, Mg and Zn in the FMI farm and Mg and S in the PN farm.

Weeds showed a superior capacity to accumulate nutrients compared to orange trees (*C. sinensis*), which, in turn, suggests their competitive potential when not controlled in their critical period. There was no interference of this presumed competition in the productive performance or development of orchards during the study. Orange plants showed no visual symptoms of nutritional deficiency. Low levels of macronutrients, especially N, P and K, reduce fruit quality and citrus production, causing visual damage and impairing the physiological functions of plants (Vashisth; Kadyampakeni, 2020). Deficiency of micronutrients such as B, Cu, Fe, Zn and Mo cause fruit cracking, plant death and leaf damage (Elavarasan; Premalatha, 2019). The critical period of weed interference in citrus orchards in the region would begin in October, when the last sampling in plantations was carried out, since then, the integrated control management in farms would begin.

To know the actual damage or interference caused by competition in orchards, it would be necessary to carry out the same study during the critical period of interference (October to May). However, results outside this period are also important to endorse that weeds have high potential for absorption and accumulation of nutrients even when it is not causing any damages.

4 CONCLUSIONS

Nutrients contents were higher in weeds than in orange trees in commercial orchards (*C. sinensis*) in the metropolitan region of Manaus (AM).

Weeds with high amounts of nutrients were *A. phycoidea* (N, K, Mg, Cu, Mn and Zn), *C. benghalensis* (P, S and Fe), P. spiralis (N, P, K, Mg, Fe and Zn), *A. arvensis* (P and Ca), *C. diffusus* (Fe and Mn) and *S. Cayennensis* (Mg and Zn).

There was no interference of competition in the productive performance or development of orchards during the period under study. Further studies should be carried out in new commercial areas and at different times of the year to assess the effect of seasonality on weeds and competition for nutrients with the main crop.

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