









## Article

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## WEED PHYTOSOCIOLOGY IN CASSAVA CULTIVATION IN TWO PERIODS IN SOUTHWESTERN BAHIA, BRAZIL

*Fitossociologia de Plantas Daninhas na Cultura da Mandioca em Dois Períodos no Sudoeste da Bahia, Brasil*

**ABSTRACT** - Knowing the most important species in the weed community is necessary to decide the best weed control method to be used. Thus, a phytosociological survey was carried out on cassava cultivation areas located in five rural properties of Cândido Sales, BA, Brazil, one of the state's largest cassava producers. Two collections were carried out in each property in February (summer) and August (winter) 2016. A square metal frame with 0.25 m<sup>2</sup> was randomly placed in each area, zigzagging, and establishing a proportion of 25 castings per hectare, with a sampling area of 6.25 m<sup>2</sup> in each area. Weeds were identified and quantified, and then phytosociological parameters of frequency, density, abundance, relative frequency, relative density, relative abundance, and importance value index were determined. The analysis of the similarity between populations of the areas and periods was determined by the Sorensen similarity index. A variation of weed community composition was observed between cassava and harvest periods, with a higher infestation in the summer. A similarity was observed between cassava cultivation areas.

**Keywords:** *Manihot esculenta* Crantz, floristic composition, diversity of invasive species.

**RESUMO** - Para decidir qual o melhor método de controle de plantas daninhas a ser utilizado, é necessário conhecer as espécies mais importantes na comunidade dessas plantas. Assim, foi realizado um levantamento fitossociológico em lavouras de mandioca localizadas em cinco propriedades rurais do município de Cândido Sales-BA, um dos maiores produtores de mandioca do Estado. Em cada propriedade foram feitas duas coletas, no mês de fevereiro (verão) e agosto (inverno) do ano de 2016. Foi utilizada uma armação metálica quadrada com 0,25 m<sup>2</sup>, lançada aleatoriamente em cada área, fazendo um caminhar em ziguezague e estabelecendo uma proporção de 25 lançamentos por hectare, com área de amostragem de 6,25 m<sup>2</sup> em cada área. As plantas daninhas foram identificadas e quantificadas e, posteriormente, procedeu-se à determinação dos parâmetros fitossociológicos de frequência, densidade, abundância, frequência relativa, densidade relativa, abundância relativa e índice de valor de importância. A análise de semelhança entre as populações das áreas e épocas foi determinada pelo Índice de Similaridade de Sorensen. Houve variação da composição da comunidade de plantas daninhas entre as lavouras de mandioca e épocas de coleta, com maior infestação no verão. Observou-se similaridade entre as áreas de cultivo de mandioca.

**Palavras-chave:** *Manihot esculenta* Crantz, composição florística, diversidade de espécies invasoras.

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## INTRODUCTION

Cassava is a perennial, shrub-like, heliophyte plant that develops in tropical and subtropical regions of the world (Onyenwoke and Simonyan, 2014). It plays an important role in agriculture and development of Brazil, mainly in the Northeast, where it develops well in poor soils and with low precipitation indices in the region.

In the '70s, Brazil was the world's largest cassava producer, with about 30 million tons of this root. This production was reduced to around 18.87 million tons, with a mean yield of 14.35 t ha<sup>-1</sup> in 2017 (IBGE, 2018), being Brazil considered the world's fourth-largest producer behind Nigeria, Thailand, and Indonesia, according to the latest world survey conducted by the Food and Agriculture Organization of the United Nations in 2016 (FAO, 2018).

The state of Bahia stands out in the production of cassava, being among the three largest producers of Brazil, with a production of approximately 1.96 million tons and a 9.10% share of the national production, behind Pará and Paraná, which have a production of around 4.26 and 3.88 million tons, respectively (IBGE, 2018).

Cândido Sales, BA, is the most outstanding in Bahia. In the past, this municipality was already the largest cassava national producer but currently occupies the 10th place in the state, with a production in 2016 of 38,000 tons and a mean yield of 6.33 t ha<sup>-1</sup> (IBGE, 2018). Cassava has high economic and social importance, with large participation in the family income of many farmers in the region.

According to Albuquerque et al. (2014), among the factors responsible for the low cassava yield in Brazil, inadequate weed management stands out. The main methods used to control weeds in cassava in southwestern Bahia are the mechanical, usually by manual weeding and more used in small properties, and the chemical, using herbicides and adopted in large areas of cultivation, but still little used. The choice of control method is directly related to the financial conditions of the farmers and their access to workforce and equipment (Silva et al., 2012).

However, knowing the most important species in the weed community is essential to decide the best control method to be used. For this, phytosociological surveys that will provide an overall view of the composition and distribution of weed species are carried out. This knowledge enables the formation of more effective weed management programs in cultivated areas.

Therefore, this study aimed to identify and quantify the main weed species present in the summer and winter in areas of cassava cultivation in the municipality of Cândido Sales, BA, Brazil.

## MATERIAL AND METHODS

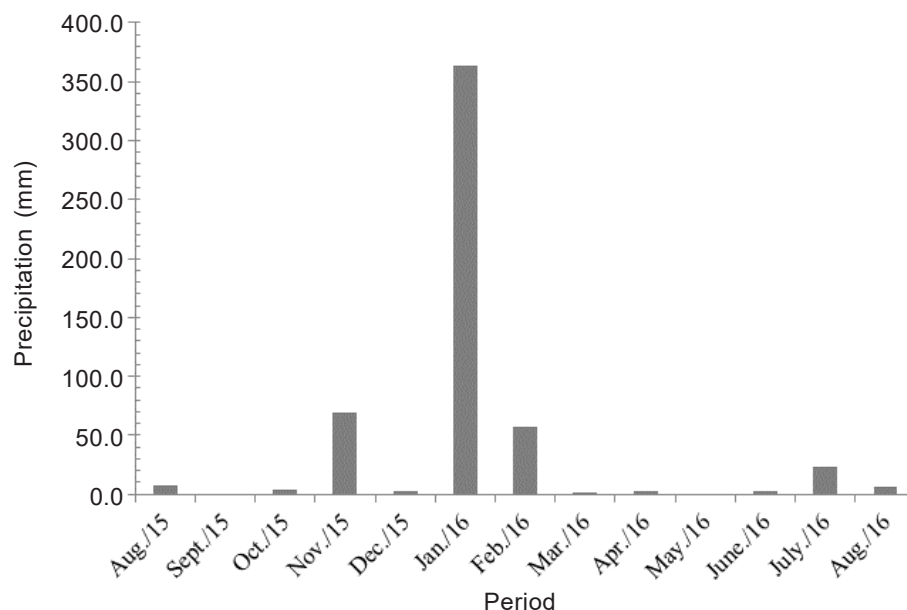
### Location and characterization of the study areas

The survey was carried out in the rural area of the municipality of Cândido Sales, southwest of the state of Bahia, close the district of Lagoa Grande, with a mean altitude of 627 m, whose geographical coordinates are shown in Table 1. The climate, according to Köppen classification, is Aw (tropical climate with a dry season), with a mean annual precipitation of 767.4 mm, concentrated between October and March, and annual mean temperature of 20.4 °C (SEI, 2013) (Figure 1).

In this region, cassava is grown in areas ranging from 1 to 5 hectares, with planting carried out mainly from October to December, which is the beginning of the rainy season. Stem cuttings are planted in pits, with no defined spacing. Roots are harvested at 18 to 24 months after planting, from June to September, the period of physiological rest of cassava plants and time of the highest starch accumulation in the roots.

**Table 1** - Geographical coordinates of cassava areas used in the phytosociological survey carried out in Cândido Sales, BA, Brazil

Area	Location	Latitude	Longitude
A	Barra do Furado	15°15'09.936" S	41°18'28.577" W
B	Bomba	15°18'29.131" S	41°19'45.437" W
C	Possidônio	15°17'27.805" S	41°20'49.574" W
D	Barra do Furado	15°16'37.106" S	41°20'46.586" W
E	Bomba	15°16'25.925" S	41°17'56.749" W



**Figure 1** - Monthly averages of rainfall, National Water Agency (ANA, 2016), from August 2015 to August 2016, from the municipality of Cândido Sales - Bahia.

Farmers grew more than one variety in the same area mainly due to the difficulty of finding stem cuttings in the planting season, with a preference for erect habit varieties, which facilitate weed control. Among the main varieties used in the region are Platinão, Sergipe, Juliana, and Periquita, which are destined for flour production.

No soil conservation practices are used. The conventional soil tillage is used, with the burning of the area. In general, farmers do not correct the soil and do not fertilize their crops.

For this study, five areas (A, B, C, D, and E) of cassava cultivation were selected from traditional local farmers (Table 1). Visits were carried out in the properties for the application of questionnaires to obtain information on cassava management practices, and then, weed collections.

Soil samples were collected in the five properties for chemical characterization (Table 2). Soil chemical analyses were carried out at the Laboratory of Soils of the Southwestern Bahia State University.

**Table 2** - Soil chemical attributes of five properties in Cândido Sales, BA, Brazil

Property	pH	P	K <sup>+</sup>	Ca <sup>2+</sup>	Mg <sup>2+</sup>	Al <sup>3+</sup>	H <sup>+</sup>	SB	t	T	V	m
	(H <sub>2</sub> O)	(mg dm <sup>-3</sup> )	(cmolc dm <sup>-3</sup> soil)							(%)		
A	4.5	2	0.16	0.7	0.3	1.0	4.8	1.2	2.2	7.0	17	46
B	4.3	3	0.08	0.6	0.3	1.2	6.0	1.0	2.2	8.2	12	55
C	4.6	2	0.09	0.9	0.4	0.7	3.1	1.4	2.1	5.2	27	33
D	4.1	2	0.07	0.5	0.3	1.4	4.4	0.9	2.3	6.7	13	62
E	4.5	2	0.09	0.8	0.5	1.2	6.0	1.4	2.6	8.6	16	46

SB = sum of exchangeable bases; t = effective CEC; T = CEC at pH 7.0; V = base saturation; m = aluminum saturation.

### Weed survey

Two surveys were carried out in each property: the first survey in February 2016 (summer), at the beginning of cassava development, when plants were, on average, three months old; and the second survey in August 2016 (winter), when cassava plants were, on average, nine months old. A square metal frame with an area of 0.25 m<sup>2</sup> was randomly placed on each studied area, zigzagging, and using the square-inventory method proposed by Braun-Blanquet (1979).

A proportion of 25 castings were used per hectare, totaling a sampling area of 6.25 m<sup>2</sup> in each studied area per period to characterize most of the weed species present in the area, according to Ariza (2010).

Weeds present in each sampled area were cut close to the soil, packed in plastic bags, and taken for identification and quantification. The following phytosociological parameters were determined (Mueller-Dombois and Ellenberg, 1974): a) frequency (F) = number of frames containing the species/total number of frames; b) density (D) = total number of individuals per species/total collected area; c) abundance (A) = total number of individuals per species/total number of squares containing the species; d) relative frequency (Fr) = (frequency of species/total frequency of species) × 100; e) relative density (Dr) = (density of species/total density of species) × 100; f) relative abundance (Ar) = (abundance of species/total abundance of species) × 100; g) importance value index (IVI) = Fr + Dr + Ar.

The similarity index (SI) of weeds (Sorensen, 1972) was determined for analyzing the similarity between weed populations from different areas and collection times, being determined as  $SI = (2 \times \text{number of species common to both areas}) \times 100 / (\text{total number of species determined in one area} + \text{total number of species determined in another area})$ .

The data related to the weed community were submitted to descriptive statistical analysis.

## RESULTS AND DISCUSSION

The interviewed farmers performed plowing operations using machinery in 2016. According to Carvalho et al. (2007), the use of fire is still a common practice in soil preparation for cassava planting in southwestern Bahia, and it is more evident in areas to be planted for the first time. In general, farmers grow four to five times at the same place and, after the fifth cultivation, they usually do not cultivate in that area for a few years, a process called by the farmers as rest. In this case, farmers search for another place for new cultivations.

Weed control is carried out using manual weeding with a hoe, and the interviewed farmers have never performed chemical control. The highest number of manual weeding is carried out between the first three to four months after planting, a period considered as critical for cassava cultivation. Albuquerque et al. (2012), in a study on the development of cassava under weed interference in Viçosa, MG, showed that weed control should be started around 25 days after planting and coexistence by an interval higher than or equal to 50 days after planting, reducing the stem diameter and height of cassava plants, as well as the number and length of tuberous roots.

According to Silva et al. (2012), the planting of cultivars adapted to climate and soil conditions, the use of healthy stem cuttings, correct spacing and arrangement of plants for different cultivars, soil tillage, and adequate planting fertilization are practices that can help in the control of weeds in cassava.

The interviews showed that the yield of tuberous roots is low, ranging from 6.0 to 11.0 t ha<sup>-1</sup>. This low yield may be associated, in addition to other factors, with unsatisfactory weed control, especially in the initial months of crop development.

In the survey carried out on the five areas of cassava cultivation and two seasons, 28 weed species were identified and divided into 23 genera and 12 families (Table 3). Similar results were found by Moreira (2016), who observed 31 species and 11 families in a survey carried out in the same region, in which Fabaceae, Malvaceae, and Poaceae families stood out. Soares et al. (2015) observed 38 species divided into 14 families in Vitória da Conquista, BA, being Asteraceae, Fabaceae, Malvaceae, and Poaceae families those with the highest occurrence.

In the collection carried out in the summer, 27 weed species were identified, being distributed into 12 botanical families. The families that presented the highest occurrence were Fabaceae, Malvaceae, and Poaceae, with five species each (Table 4). This number of species may have been favored by the high pluviometric indices that occurred in the summer, showing an accumulation of approximately 420 mm. Albuquerque et al. (2014) observed a heterogeneous community with 27 weed species in a cassava area in Roraima, with a higher prevalence of Poaceae, Fabaceae, and Asteraceae families.

**Table 3** - List of weed species identified from the phytosociological survey carried out in areas of cassava cultivation in Cândido Sales, BA, Brazil

Family	Scientific name	Common name
Amaranthaceae	<i>Alternanthera brasiliana</i> (L.) Kuntze	Brazilian joyweed
Asteraceae	<i>Acanthospermum australe</i> (Loefl.) Kuntze	Paraguay starbur
Convolvulaceae	<i>Evolvulus anagalloides</i> Meisn.	Dwarf morning-glory
	<i>Merremia cissoides</i> (Lam.) Hall. f.	Roadside woodrose
Euphorbiaceae	<i>Croton glandulosus</i> L.	Vente conmigo
Fabaceae	<i>Chamaecrista nictitans</i> (L.) Moench	Sensitive partridge pea
	<i>Chamaecrista rotundifolia</i> (Pers.) Greene	Roundleaf sensitive pea
	<i>Desmodium tortuosum</i> (Sw.) DC.	Florida beggarweed
	<i>Macroptilium atropurpureum</i> (OC.) Urb.	Purple bushbean
	<i>Stylosanthes guianensis</i> (Aubl.) Sw.	Pencilflower
Lamiaceae	<i>Hyptis suaveolens</i> (L.) Poit.	Pignut
Malvaceae	<i>Malvastrum coromandelianum</i> (L.) Garcke	Threelobe false mallow
	<i>Pavonia cancellata</i> (L.) Cav.	Swampmallow
	<i>Sida cordifolia</i> L.	Heartleaf sida
	<i>Sida</i> ssp.	Fanpetals
	<i>Sidastrum micranthum</i> (A. St.-Hil.) Fryxell	Sandmallow
Molluginaceae	<i>Mollugo verticillata</i> L.	Green carpetweed
Poaceae	<i>Cenchrus echinatus</i> L.	Southern sandbur
	<i>Digitaria horizontalis</i> Willd.	Jamaican crabgrass
	<i>Digitaria insularis</i> (L.) Fedde.	Sourgrass
	<i>Rhynchelytrum roseum</i> (Nees) Stapf & Hubb.	Rose Natal grass
	<i>Setaria parviflora</i> (Poir.) Kerguelen	Knotroot foxtail
Portulacaceae	<i>Portulaca oleracea</i> L.	Common purslane
	<i>Portulaca umbraticola</i> Kunth	Wingpod purslane
Rubiaceae	<i>Diodella teres</i> (Walter) Small	Poorjoe
	<i>Richardia brasiliensis</i> (Gomes)	Brazil pusley
Solanaceae	<i>Solanum paniculatum</i> L.	Nightshade
	<i>Solanum stipulaceum</i> Roem. & Schult.	Nightshade

Source: Lorenzi (1994); Lorenzi (2000); Lorenzi (2006); Moreira and Bragança (2011).

The species with the highest values of F, Fr, D, and Dr in the summer were *Diodella teres* and *Acanthospermum australe*. However, the highest values of A and Ar were verified in *Digitaria horizontalis*, *D. teres*, and *A. australe* (Table 4). Moreira (2016) pointed out that the highest incidence of *D. teres* is usually observed in manually prepared and non-fertilized areas, the case of cassava cultivations of the region, where most farmers use only one plowing operation. The initial soil tillage is usually performed in a traditional way, which consists of cutting the vegetation and burning the branches. Also, about 80% of the interviewed farmers said that they do not use any soil fertilization.

In general, soil chemical analysis showed acid and nutrient-poor soils (Table 2). The pH levels ranged from 4.1 to 4.6, below that ideal for cassava cultivation, which is within a range of 5.5 to 6.5, according to Lorenzi et al. (2002). Values of P, Ca<sup>2+</sup>, Mg<sup>2+</sup>, and K<sup>+</sup> were also below the ideal for cassava cultivation, except for property A, which presented a value of K<sup>+</sup> of 0.16 cmol<sub>c</sub> dm<sup>-3</sup> of soil, a value considered suitable for the cassava crop. However, according to Ferreira et al. (2014), weeds can take higher advantage of soil nutrients such as phosphorus and potassium because of their higher resistance and rusticity when compared to cultivated crops.

Souza Filho et al. (2001) studied variations occurring in weed seed germination in response to soil-related factors and observed no changes in seed germination in a pH range from 3.0 to 11.0, with no difference also for calcium and magnesium contents of 0.0–6.0 and 0.0–12.0 cmol<sub>c</sub> dm<sup>-3</sup> of soil, respectively, thus demonstrating the rusticity of these plants.

**Table 4** - Number of frames with the presence of species (NF), number of individuals (NI), frequency (F), relative frequency (Fr), density (D), relative density (Dr), abundance (A), relative abundance (Ar), and importance value index (IVI) of weed species collected in five areas of cassava cultivation in February in Cândido Sales, BA, Brazil

Species	NF	NI	F	Fr%	D	Dr%	A	Ar%	IVI
<i>Diodella teres</i>	66	561	0.53	19.02	17.95	39.26	8.50	11.41	69.68
<i>Acanthospermum australe</i>	47	288	0.38	13.54	9.22	20.15	6.13	8.22	41.92
<i>Croton glandulosus</i>	31	72	0.25	8.93	2.30	5.04	2.32	3.12	17.09
<i>Portulaca umbraticola</i>	17	80	0.14	4.90	2.56	5.60	4.71	6.31	16.81
<i>Solanum paniculatum</i>	21	65	0.17	6.05	2.08	4.55	3.10	4.15	14.75
<i>Pavonia cancellata</i>	29	50	0.23	8.36	1.60	3.50	1.72	2.31	14.17
<i>Digitaria horizontalis</i>	2	18	0.02	0.58	0.58	1.26	9.00	12.08	13.91
<i>Rhynchelytrum repens</i>	17	54	0.14	4.90	1.73	3.78	3.18	4.26	12.94
<i>Solanum stipulaceum</i>	22	49	0.18	6.34	1.57	3.43	2.23	2.99	12.76
<i>Chamaecrista rotundifolia</i>	11	31	0.09	3.17	0.99	2.17	2.82	3.78	9.12
<i>Digitaria insularis</i>	12	30	0.10	3.46	0.96	2.10	2.50	3.35	8.91
<i>Cenchrus echinatus</i>	3	12	0.02	0.86	0.38	0.84	4.00	5.37	7.07
<i>Mollugo verticillata</i>	4	14	0.03	1.15	0.45	0.98	3.50	4.70	6.83
<i>Setaria parviflora</i>	8	18	0.06	2.31	0.58	1.26	2.25	3.02	6.58
<i>Malvastrum coromandelianum</i>	5	15	0.04	1.44	0.48	1.05	3.00	4.03	6.52
<i>Sidastrum micranthum</i>	9	15	0.07	2.59	0.48	1.05	1.67	2.24	5.88
<i>Hyptis suaveolens</i>	9	11	0.07	2.59	0.35	0.77	1.22	1.64	5.00
<i>Portulaca oleracea</i>	7	11	0.06	2.02	0.35	0.77	1.57	2.11	4.90
<i>Richardia brasiliensis</i>	3	7	0.02	0.86	0.22	0.49	2.33	3.13	4.49
<i>Merremia cissoides</i>	6	8	0.05	1.73	0.26	0.56	1.33	1.79	4.08
<i>Macroptilium atropurpureum</i>	5	6	0.04	1.44	0.19	0.42	1.20	1.61	3.47
<i>Stylosanthes guianensis</i>	4	5	0.03	1.15	0.16	0.35	1.25	1.68	3.18
<i>Sida cordifolia</i>	4	4	0.03	1.15	0.13	0.28	1.00	1.34	2.77
<i>Alternanthera brasiliana</i>	2	2	0.02	0.58	0.06	0.14	1.00	1.34	2.06
<i>Chamaecrista nictitans</i>	1	1	0.01	0.29	0.03	0.07	1.00	1.34	1.70
<i>Desmodium tortuosum</i>	1	1	0.01	0.29	0.03	0.07	1.00	1.34	1.70
<i>Sida spp.</i>	1	1	0.01	0.29	0.03	0.07	1.00	1.34	1.70
Total	125	1429	2.78	100.00	45.73	100.00	74.52	100.00	300.00

The highest IVI was observed in the species *D. teres* and *A. australe*, with values of 69.68 and 41.92%, respectively (Table 4). In a study carried out in cassava plantation in Vitória da Conquista, BA, Cardoso et al. (2013) observed that the species *Cynodon dactylon*, *Sida rhombifolia*, *A. australe*, and *D. teres* are among those with the highest importance value index.

Alcântara and Carvalho (1983) evaluated the floristic composition of weeds in areas of cassava cultivation in Diamantina, MG, and verified that *A. australe* and *D. teres* are among the most frequent species, with occurrence in all samplings performed, which shows their importance to the crop.

Ferreira et al. (2014) performed a phytosociological survey of weeds in degraded pastures of the middle Rio Doce Valley in Minas Gerais and verified that the highest relative frequency was obtained by *A. australe*. On the other hand, Borchardt et al. (2011) studied periods of weed interference in common bean and observed that this same species had the highest relative density, showing its importance in other crops spread throughout the country. Studies carried out with the cassava crop in southwestern Bahia have shown the presence of this weed (Soares et al., 2015; Moreira, 2016), evidencing the importance of controlling this species in cassava areas of the region.

Table 5 shows that 13 weed species were identified in the collection carried out in the winter, being distributed into 10 families. The main families were Convolvulaceae, Malvaceae, and Solanaceae with two individuals each. Teixeira et al. (2009) studied weed competition with bean and verified higher importance of dicotyledonous infestation in the dry season when compared to the rainy season. This same behavior could be identified in the present study.

**Table 5** - Number of frames with the presence of species (NF), number of individuals (NI), frequency (F), relative frequency (Fr), density (D), relative density (Dr), abundance (A), relative abundance (Ar), and importance value index (IVI) of weed species collected in five areas of cassava cultivation in August in Cândido Sales, BA, Brazil

Species	NF	NI	F	FR%	D	Dr%	A	Ar%	IVI
<i>Solanum stipulaceum</i>	37	42	0.30	25.87	1.34	25.93	1.14	7.99	59.79
<i>Solanum paniculatum</i>	28	34	0.22	19.58	1.09	20.99	1.21	8.55	49.12
<i>Acanthospermum australe</i>	29	33	0.23	20.28	1.06	20.37	1.14	8.01	48.66
<i>Alternanthera brasiliana</i>	9	10	0.07	6.29	0.32	6.17	1.11	7.83	20.29
<i>Sidastrum micranthum</i>	10	10	0.08	6.99	0.32	6.17	1.00	7.04	20.21
<i>Croton glandulosus</i>	5	8	0.04	3.50	0.26	4.94	1.60	11.27	19.70
<i>Merremia cissoides</i>	8	8	0.06	5.59	0.26	4.94	1.00	7.04	17.58
<i>Pavonia cancellata</i>	8	8	0.06	5.59	0.26	4.94	1.00	7.04	17.58
<i>Evolvulus anagalloides</i>	4	4	0.03	2.80	0.13	2.47	1.00	7.04	12.31
<i>Macroptilium atropurpureum</i>	2	2	0.02	1.40	0.06	1.23	1.00	7.04	9.68
<i>Diodella teres</i>	1	1	0.01	0.70	0.03	0.62	1.00	7.04	8.36
<i>Hyptis suaveolens</i>	1	1	0.01	0.70	0.03	0.62	1.00	7.04	8.36
<i>Setaria parviflora</i>	1	1	0.01	0.70	0.03	0.62	1.00	7.04	8.36
Total	125	162	1.14	100.00	5.18	100.00	14.20	100.00	300.00

Moreira (2016) identified 19 weed species under different soil tillage systems at 180 days after cassava planting (May), which is the beginning of the period of the lowest temperatures and thus the period of physiological rest of the crop. However, 12 different species were identified when using traditional soil tillage without fertilization.

Regarding the phytosociological indices of weeds, *Solanum stipulaceum* was the species that obtained the highest IVI, with a value of 59.79%, followed by *Solanum paniculatum* and *A. australe*, with values of 49.12 and 48.66%, respectively (Table 5).

These two species with higher IVI (*S. stipulaceum* and *S. paniculatum*) were cited by farmers among those of greatest difficulty of control. These species can resprout through vegetative parts, such as stem and root, which are buried after soil tillage process for planting cassava in the areas, showing their rusticity in the driest period of the year. According to Guaraná et al. (2011), *S. paniculatum* is a weed of pasture or abandoned areas widespread in the North and Northeast regions, but found throughout the country.

Table 6 shows that the highest similarity index in the summer was found between properties C and D, with 73.33% similarity between weed species, which represents 11 species in common. In the winter, the highest similarity occurred between areas B and C, with a value of 80%. These high indices probably occurred due to the similarity between crop management and varieties used. According to Carvalho and Pitelli (1992), similarity indices are not only related to soils or distance between areas but may be related to the management used in the areas.

According to Sarmento et al. (2015), values above 25% already indicate a similarity between the compared factors. Thus, similarities were observed in all areas. Also, the similarity index considers only the absence and presence of a species or set of plants, failing to consider information such as density and dry matter of weed species (Coelho, 2014).

In all, 1591 individuals were counted, being 1429 individuals collected in the summer and 162 individuals in the winter. Climate

**Table 6** - Similarity index (%) among five areas of cassava cultivation in August in Cândido Sales, BA, Brazil

Summer				
Area	B	C	D	E
A	54.55	58.06	68.97	52.17
B	-	64.71	62.50	38.46
C	-	-	73.33	41.67
D	-	-	-	45.45
Winter				
Area	B	C	D	E
A	76.92	75.00	42.86	53.33
B	-	80.00	46.15	71.43
C	-	-	62.50	70.59
D	-	-	-	66.67

differences between the two seasons were the main factors that influenced this difference. The highest precipitation volumes in the region are concentrated in the summer, besides high luminosity and temperature indices, thus favoring germination and development of most of the weeds found in the areas.

According to the interviewed farmers, the planting season in the region depends mainly on the beginning of rains from October to December. All the farmers asserted that the highest number of weeding operations is carried out at the initial development stage of the crop, i.e., around three months after planting, due to a higher weed infestation related to the rainy season.

The number of weeds is also strongly influenced by the type of management used in each area. According to Silva et al. (2012), weed infestation is favored by canopy architecture, spacing, and slow initial growth of cassava.

Lima et al. (2015) studied weed phytosociology in guava orchards at different sampling times in Bananeiras, PB, and pointed out that different species stood out at each collection time due to several factors, such as species characteristics, climate, seed bank, crop development, time of control, and control method.

Thus, weed community composition varied between areas of cassava cultivation and between harvest seasons, with a higher infestation in the summer.

Weed families with the highest number of species in the summer were Malvaceae, Fabaceae, and Poaceae, with five species each. On the other hand, the highest number of species and in the winter was observed in the families Convolvulaceae, Malvaceae, and Solanaceae, with two species each.

The most important species regarding the phytosociological indices in the summer collection was *D. teres* and *A. australe*. However, the species *S. stipulaceum* and *A. australe* predominated in the winter. Cultivation areas usually have a high similarity index.

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