

## Weed community composition in different agro-systems

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### Abstract

Weed communities in agricultural systems are diverse and subjected to different agronomic practices. In this study, a phytosociological survey of the weed community in different cropping systems consisting of corn, horticulture, perennial cultivation of *Jatropha curcas* and pasture of *Urochloa brizantha* in Rio Verde, GO, Brazil, was carried out. Assessments were performed at the beginning (October 2011) and at the end (March 2012) of the rainy season. After identifying and counting species, were calculated the phytosociological indices of density, frequency, abundance and relative importance, as well as the diversity index of Shannon-Wiener, evenness index of Pielou and similarity coefficient of Sorensen. Were found 46 species of sixteen families, especially Poaceae. The most important species were: *Alternanthera tenella* in the annual growth environment during the both periods; *Panicum maximum* (early rainy season) and *Chamaescy hirta* (end of the rainy season) in the vegetable garden; *Eleusine indica* (early rainy season) and *Galinsoga parviflora* (end of the rainy season) in the perennial crop and *Sida rhombifolia* (early rainy season) and *Neonotonia wightii* (end of the rainy season) in the pasture. Lower diversity indices and evenness were observed in the pasture environment. Sampling time presented a higher impact on similarities when compared to the different environments.

**Keywords:** *Jatropha curcas*, corn, pasture, no-fillage

### Composição florística de comunidades de plantas daninhas em diferentes agrossistemas

#### Resumo

Comunidades de plantas daninhas em agrossistemas são diversificadas devido às práticas agrônomicas adotadas. Neste trabalho realizou-se um levantamento fitossociológico em comunidade de plantas daninhas em diferentes sistemas de cultivo constituídos de cultivo de milho, olericultura, cultivo perene com pinhão-mansão e pastagem de *Urochloa brizantha*, em Rio Verde, GO, no início (outubro de 2011) e no final (março de 2012) da época chuvosa. Após identificação e contagem das espécies calcularam-se os índices fitossociológicos: densidade, frequência, abundância e importância relativa, e os índices de diversidade de Shannon-Wiener e equitabilidade de Pielou e o coeficiente de similaridade de Sorensen. Encontrou-se 46 espécies, distribuídas em dezesseis famílias, com destaque para Poaceae. As espécies mais importantes foram *Alternanthera tenella* no ambiente de cultivo anual em ambas as épocas; *Panicum maximum* (início da época chuvosa) e *Chamaescy hirta* (final da época chuvosa) em horta; *Eleusine indica* (início da época chuvosa) e *Galinsoga parviflora* (final da época chuvosa) em cultivo perene; e *Sida rhombifolia* (início da época chuvosa) e *Neonotonia wightii* (final da época chuvosa) em pastagem. Menores índices de diversidade e de equitabilidade foram observados em área de pastagem. Quanto às similaridades entre tratamentos, a época foi mais determinante do que os ambientes, considerando que as semelhanças entre ambientes foram maiores dentro da mesma época amostrada, exceto para a pastagem no final da estação chuvosa.

**Palavras-chave:** *Jatropha curcas*, milho, pastagens, plantio direto

Received: 07 November 2015  
Accepted: 11 November 2016

## Introduction

Phytosociological studies can describe and evaluate natural environments and agro-systems based on plant community characteristics. Such studies can also allow comparisons between weed populations in a given time and space (Correa et al., 2011). Especially in weed communities, continuous evaluations of the floristic composition can indicate trends of variation of the importance of one or more populations; such variations may be associated with agricultural practices (Concenço et al., 2015).

Within agroecosystems, weed communities may interfere on growth, development and consequently on the productivity of cultivated plants, if not managed properly (Ciuberkis et al., 2007). In a study over a period of six years, the weed population dynamics in corn crop was affected by tillage systems (no tillage and conventional tillage with ploughing and harrowing) and by herbicide application and mowing (Correa et al., 2011). In this study, a conventional tillage system increased the relative importance of *Cyperus rotundus*, *Cynodon dactylon* and *Ipomoea grandifolia*. In contrast, no-tillage system increased the occurrence of *Bidens pilosa*.

Similarly, changes in the composition of weed communities were also observed in different agricultural crops, such as sugarcane (Kuva et al., 2007; Soares et al., 2011), pastures (Ferreira et al., 2014), bean (Tavares et al., 2013), cover crops (Lima et al., 2014; Lamego et al., 2015), manioc (Cardoso et al., 2013; Soares et al., 2015), corn (Correa et al., 2011), corn intercropped with legumes (Oliveira et al., 2014) and corn intercropped with forage (Batista et al., 2014; Concenço et al., 2015), millet (Teodoro et al., 2015), lettuce (Ferreira et al., 2013), *Jatropha curcas* (Concenço et al., 2014) and coffee under organic management (Maciel et al., 2010a; Partelli et al., 2010).

To analyse impacts of management and farming practices on growth dynamics and occupation of weeds, phytosociological indexes are necessary tools (Concenço et al., 2013). The evaluation of such indices for weed communities in agro-systems allows the adoption of weed

control measurements, including managing species of great relative importance (Cruz et al., 2009).

The objective of this research was use phytosociological surveys to evaluate the weed community composition in agro/systems of corn crop, perennial crop with *Jatropha curcas*, vegetable gardens and pastures at the beginning and at the end of the rainy season.

## Material and methods

The floristic survey was conducted in October 2011 and March 2012 at the experimental area of the Goiano Federal Institute of Education, Science and Technology (IF Goiano) located in the municipality of Rio Verde, GO, Brazil (17°48'67" S; 50°54'18" W; 754m). The climate in this region, according to Köppen, is Aw, defined as humid tropical characterised by two distinct seasons: a dry season from April to October and a humid season, with heavy rainfalls, from November to March. The annual average rainfall is 1,800 mm and the annual average temperature is 24°C.

Sampling was carried out in four contiguous areas with different crop systems: corn crop, vegetable garden, perennial crop with *Jatropha curcas* and pasture with *Urochloa brizantha*. Under corn cultivation, the soil disturbance was minimal due to the adopted system (no-tillage); liming and fertilization were performed according to the requirements of the crop, after the chemical-physical analysis of the soil. Weed control was performed with specific herbicides, predominantly glyphosate.

The horticulture area was characterized by constant soil disturbance, high fertility and high water availability. Constant crop rotation included lettuce, cabbage, garlic, onions and carrots. Weed control was carried out mechanically and manually.

The perennial crop environment was cultivated during two years with *Jatropha curcas*. This system experienced no soil disturbance and in the dry season, the crop was irrigated to meet the water requirement. Weed control was carried out manually, by mowing and with the use of glyphosate between lines.

The *Urochloa brizantha* pasture was characterized by lack of soil disturbance and the

absence of liming; soil fertility was not maintained through fertilization. Weed control was performed by mowing.

Except for the *Jatropha curcas* plot, all areas assessed have been used for crops grown for more than 10 years at the time of this study.

Each environment was divided into similar areas of approximately two hectares in which sixteen samples points per crop systems were used. At each sampling spot, a metallic square of 0.25 m<sup>2</sup> (0.5 x 0.5 m) was randomly placed, identifying and counting weeds. The procedure was performed in two seasons (beginning and end of the rainy season), with the first assessment on October 28, 2011 and the second on March 19, 2012.

After the identification and counting the individuals, the following phytosociological indices were estimated: relative density [RD = (species density x 100) /  $\sum$  densities]; relative frequency [RF = (species frequency x 100) /  $\sum$  frequency]; relative abundance [RAB = (species abundance x 100) /  $\sum$  abundance]; importance value index [IVI =  $\sum$ (RD; RF; RAB)], which is the weighted evaluation of previous contents and the relative importance [RI = (IVI x 100) / 300], which is the percentage representation of the IVI.

The Shannon-Wiener diversity index [ $H = -\sum_{i=1} p_i \ln(p_i)$ ] (Pinto Coelho, 2000) was calculated, where  $p_i$  is the proportion of the sample containing individuals of the population  $i$ ; and the evenness index of Pielou or uniformity [ $J = H / H_{\max}$ ], which is the ratio of the population diversity index and the maximum and theoretical diversity index, obtained when the rated factor shows no variation between populations.

Similarities between environments and samplings were estimated using the Sorensen coefficient. Similarity estimates were interpreted with a dendrogram constructed using the unweighted average (UPGMA). To estimate the adjustment between the dissimilarity matrix and the dendrogram, the cophenetic correlation coefficient ( $r$ ) was calculated.

## Results and discussion

Were identified 13,123 individuals of 46 species and sixteen botanical families. Most individuals (86.7%) occurred in the early rainy

season, while in the dry season, 13.3% were sampled. The families Poaceae (11), Asteraceae (9), Amaranthaceae (4), Euphorbiaceae (4) and Fabaceae (4) presented the largest number of species, considering the four environments and the two evaluation periods.

The five species that presented the higher frequencies at the beginning of the rainy season were *Nicandra physaloides* (20.0%), *Galinsoga parviflora* (14.0%), *Commelina benghalensis* (14.0%), *Panicum maximum* (12.0%) and *Portulaca oleracea* (10.0%), belonging to the families Solanaceae, Asteraceae, Commelinaceae, Poaceae and Portulacaceae, respectively. In the dry season, species with higher frequencies were *Digitaria horizontalis* (12.7%), *Commelina benghalensis* (12.0%), *Eleusine indica* (9.1%), *Portulaca oleracea* (7.6%) and *Galinsoga parviflora* (6.5%), belonging, respectively, to the families Poaceae, Commelinaceae, Poaceae, Portulacaceae and Asteraceae.

Species of the Poaceae family usually have high phenotypic plasticity, with more competitive characteristics, such as the production of large numbers of seeds, alternative forms of propagation and a high capacity of spread, justifying the occurrence of this family in different environments (Blanco, 2014). Similar results were observed by Tavares et al. (2013) in bean crops at three sowing dates, by Maciel et al. (2010a) in organically cultivated coffee, by Cunha et al. (2014) in pepper cultivation in no and conventional tillage systems and by Maciel et al. (2010b) with lawns.

In table 1 the floristic composition of weeds in the annual corn crop is presented, evaluated at the beginning and end of the rainy season, respectively. The five weed species with the highest RF values in the early rainy season were *Commelina benghalensis* (13.9%), *Cyperus rotundus* (9.6%), *Solanum americanum* (9.6%), *Bidens pilosa* (8.7%) and *Zea mays* (8.7%), consisting of "volunteer corn plant" from the previous crop. At the end of the rainy season, the species *Digitaria horizontalis* (12.4%), *Urochloa plantaginea* (12.4%), *C. benghalensis* (11.5%), *Alternanthera tenella* (11.5%) and *Nicandra physaloides* (8.0%) were more frequent.

**Table 1.** Frequency (RF), density (RD), abundance (RAB) and relative importance (RI) of weed species in annual corn crop, evaluated at the beginning and the end of the rainy season in Rio Verde - GO, Brazil, 2013.

Species	Beginning of the rainy season				End of the rainy season			
	RF%	RD%	RAB%	RI%	RF%	RD%	RAB%	RI%
<i>Acanthospermum australe</i>	1.7	0.14	0.09	0.66	0.88	1.2	9.3	3.8
<i>Alternanthera tenella</i>	0.87	47.7	65.9	38.2	11.5	27.1	15.9	18.2
<i>Amaranthus hybridus</i>	1.7	0.86	0.59	1.1	4.4	0.15	0.23	1.6
<i>Amaranthus retroflexus</i>	1.7	0.02	0.02	0.59	---	---	---	---
<i>Amaranthus viridis</i>	---	---	---	---	2.6	1.1	2.7	2.1
<i>Argemone mexicana</i>	---	---	---	---	6.2	8.2	9.0	7.8
<i>Bidens pilosa</i>	8.7	0.29	0.04	3.0	1.8	0.61	2.3	1.6
<i>Cenchrus echinatus</i>	0.87	1.9	2.6	1.8	---	---	---	---
<i>Chamaesyce hirta</i>	---	---	---	---	4.4	2.1	3.2	3.3
<i>Commelina benghalensis</i>	13.9	12.3	1.1	9.1	11.5	9.1	5.4	8.7
<i>Conyza bonariensis</i>	0.87	0.05	0.06	0.33	---	---	---	---
<i>Cyperus rotundus</i>	9.6	3.0	0.37	4.3	2.6	2.0	5.0	3.2
<i>Desmodium tortuosum</i>	3.5	0.07	0.02	1.2	---	---	---	---
<i>Digitaria horizontalis</i>	0.87	5.9	8.2	5.0	12.4	8.2	4.5	8.4
<i>Digitaria insularis</i>	0.87	0.05	0.06	0.33	---	---	---	---
<i>Eleusine indica</i>	1.7	8.1	5.6	5.2	7.1	11.4	10.9	9.8
<i>Galinsoga parviflora</i>	---	---	---	---	0.88	0.15	1.2	0.73
<i>Ipomoea purpurea</i>	2.6	0.41	0.19	1.1	3.5	1.2	2.3	2.4
<i>Nicandra physaloides</i>	6.1	7.4	1.5	5.0	8.0	10.4	8.8	9.0
<i>Panicum maximum</i>	0.87	7.5	10.3	6.2	0.88	0.61	4.6	2.0
<i>Pennisetum americanum</i>	7.0	0.05	0.01	2.3	---	---	---	---
<i>Portulaca oleracea</i>	0.87	2.3	3.1	2.1	6.2	4.6	5.0	5.2
<i>Ricinus communis</i>	7.0	0.16	0.03	2.4	---	---	---	---
<i>Sida rhombifolia</i>	5.2	0.20	0.05	1.8	2.6	1.7	4.3	2.9
<i>Solanum americanum</i>	9.6	1.5	0.19	3.8	---	---	---	---
<i>Tridax procumbens</i>	5.2	0.02	0.01	1.7	---	---	---	---
<i>Urochloa plantaginea</i>	---	---	---	---	12.4	10.1	5.5	9.3
<i>Zea mays</i> *	8.7	0.05	0.01	2.9	---	---	---	---

\* Refers to volunteer corn plant.

It should be noticed that in this environment, for both samplings, the species *A. tenella* showed significantly higher RI values than the other species. At the beginning of the rainy season, *A. tenella* showed a high RD value of 47.7% with concentrated distribution (RAB = 65.9%) (Table 1). Similarly, at the end of the rainy season, this species had higher RD (27.1%) and RAB (15.9%) values and, most importantly, a higher RI value (18.2%). Higher RI values for *Eleusine indica* (9.8%), *U. plantaginea* (9.3%), *N. physaloides* (9.0%), *C. benghalensis* (8.7%) and *D. horizontalis* (8.4%) were also observed (Table 1). *A. tenella* showed vigorous growth, which usually explains the large population and abundance of this specie in areas that it infests. Its rapid growth provides shading and therefore positively affects neighbouring plants (Moreira & Bragança, 2010; Batista et al., 2014). The largest expression represented in the rainy season may be related to greater water availability, favouring further

development.

In vegetable gardens, several species showed similar RF values and weeds with the highest values were *C. hirta* and *E. indica*, both with 13.2%; and *E. pilosa* with 11.3% for the first evaluation. At the end of the rainy season (second evaluation), the most frequent species were *E. indica* (16%), *D. horizontalis* (14.7%), *C. hirta* (13.3%) and *C. benghalensis* (13.3%) (Table 2). Several species showed high numbers of individuals at the beginning of the rainy season, especially *E. pilosa* (14.5%), *P. maximum* (13.6%), *D. horizontalis* (12.8%), *C. hirta* (12.7%), *A. conyzoides* (12.7%) and *G. parviflora* (11.7%). However, the most populous species did not presented higher RAB values (Table 2). Even with a median RAB value (5.3%), *E. pilosa* was characterised as a species of high RI, with 10.4%, only surpassed by *P. maximum* with 15.0%.

Towards the end of the rainy season, the species with high RD values also presented higher

values for other parameters; *C. hirta* and *D. horizontalis* were the more dense (27.7 and 17.7%, respectively) and most abundant (19.0 and 11.0%, respectively) species, with higher RI values (20.0 and 14.5%, respectively). It is noteworthy that in horticultural crops, the predominant species were *C. hirta*, *G. parviflora*, *D. horizontalis* and *E. indica*; these species can germinate and grow faster, have short development cycles

and produce high amounts of diaspores, which may favour the re-infestation (Carvalho et al., 2008a; 2008b). In general, in areas cultivated with vegetables, because of the wide availability of resources (water and nutrients) and the high frequency of soil disturbance, perennial species, such as *C. benghalensis* and *Cyperus rotundus*, are often found (Ferreira et al., 2013; Cunha et al., 2014).

**Table 2.** Frequency (RF), density (RD), abundance (RAB) and relative importance (RI) of weed species in the vegetable garden, assessed at the beginning and the end of the rainy season, in Rio Verde - GO, Brazil, 2013

Species	Beginning of the rainy season				End of the rainy season			
	RF%	RD%	RAB%	RI%	RF%	RD%	RAB%	RI%
<i>Amaranthus retroflexus</i>	0.94	0.08	0.36	0.46	1.3	0.47	3.2	1.7
<i>Ageratum conyzoides</i>	6.6	12.7	7.9	9.0	---	---	---	---
<i>Amaranthus hybridus</i>	0.94	2.9	12.7	5.5	2.7	0.93	3.2	2.3
<i>Cenchrus echinatus</i>	0.94	0.08	0.36	0.46	---	---	---	---
<i>Chamaesyce hirta</i>	13.2	12.7	4.0	10.0	13.3	27.7	19.0	20.0
<i>Commelina benghalensis</i>	6.6	2.0	1.2	3.3	13.3	10.9	7.5	10.6
<i>Conyza bonariensis</i>	9.4	2.4	1.0	4.3	4.0	3.5	8.0	5.2
<i>Cyperus rotundus</i>	1.9	0.50	1.09	1.2	9.3	8.4	8.2	8.6
<i>Digitaria horizontalis</i>	7.5	12.8	7.0	9.1	14.7	17.7	11.0	14.5
<i>Digitaria insularis</i>	0.94	0.08	0.36	0.46	8.0	8.4	9.6	8.6
<i>Duranta repens</i>	0.94	2.1	9.1	4.0	---	---	---	---
<i>Eleusine indica</i>	13.2	6.7	2.1	7.3	16.0	10.9	6.3	11.1
<i>Emilia fosbergii</i>	3.7	1.5	1.6	2.3	1.3	0.70	4.8	2.3
<i>Eragrostis pilosa</i>	11.3	14.5	5.3	10.4	---	---	---	---
<i>Galinsoga parviflora</i>	6.6	11.7	7.3	8.5	4.0	2.1	4.8	3.6
<i>Gnaphalium coractatum</i>	0.94	0.08	0.36	0.46	---	---	---	---
<i>Panicum maximum</i>	1.9	13.6	29.6	15.0	8.0	4.2	4.8	5.7
<i>Pilea microphylla</i>	0.94	0.25	1.09	0.76	---	---	---	---
<i>Portulaca oleracea</i>	5.7	1.4	1.0	2.7	4.0	4.2	9.6	5.9
<i>Richardia brasiliensis</i>	3.8	0.58	0.64	1.7	---	---	---	---
<i>Sonchus oleraceus</i>	0.94	0.17	0.73	0.61	---	---	---	---
<i>Tridax procumbens</i>	0.94	1.2	5.1	2.4	---	---	---	---

In the perennial crop environment with *Jatropha curcas* cultivation, the species with the highest RF values at the beginning of the rainy season were *E. indica* (9.5%), *C. benghalensis* (9.5%) and *Portulaca oleracea* (8.9%) (Table 3). *E. indica* also showed high RD (28.8%) RAB (19.3%) and RI (19.2%) values, followed by *C. benghalensis* and *A. tenella* with RI values of 10.5%. *A. tenella* was also the most abundant species (RAB 14.3%) at the beginning of the rainy season.

At the end of the rainy season, *G. parviflora* (17.5%), *U. decumbens* (13.7%) and *D. horizontalis* (12.5%) had higher RF values (Table 3). In terms of abundance, an important parameter defining the population size of a particular species in a particular habitat, the highest values was observed for *Sida rhombifolia* (16.9%)

and *G. parviflora* (15.7%). The determination of these species in concentrated areas is of great importance in chemical or mechanical control and allows the use of specific management practices in areas of high infestation. Similar to our study, Monquero & Silva (2007) found a high importance of grass species in agro-systems of peach and eucalyptus, especially for the species *D. horizontalis* and *U. decumbens*, respectively. In our study, RD values were also high for *G. parviflora* (30.7%), characterising it as a species of higher RI at the end of the rainy season in this system.

The use of forage crops has received considerable attention because of its competitive and allelopathic effects which alter the composition and suppress the germination of

many weeds (Bellinder et al., 2004). Table 4 shows the small number of species in this environment. At the beginning of the rainy season, *C. incana*, *S. rhombifolia* and *N. physaloides* had higher RF values compared to the other species, at

the beginning of the rainy season, reaching a combined value of 76%. Similarly, at the end of the rainy season, *N. wightii* and *C. incana* reached a combined RF value of 63.1%.

**Table 3.** Frequency (RF), density (RD), abundance (RAB) and relative importance (RI) of weed species in the perennial crop (*Jatropha curcas*) environment assessed at the beginning and the end of the rainy season, in Rio Verde - GO, Brazil, 2013

Species	Beginning of the rainy season				End of the rainy season			
	RF%	RD%	RAB%	RI%	RF%	RD%	RAB%	RI%
<i>Alternanthera tenella</i>	5.3	12.0	14.3	10.5	---	---	---	---
<i>Amaranthus hybridus</i>	---	---	---	---	1.2	0.17	1.20	0.87
<i>Amaranthus retroflexus</i>	---	---	---	---	1.2	0.17	1.20	0.87
<i>Amaranthus viridis</i>	5.9	6.7	7.2	6.6	8.7	5.2	5.3	6.4
<i>Bidens pilosa</i>	0.59	0.26	2.8	1.22	3.7	1.9	4.4	3.3
<i>Cenchrus echinatus</i>	2.4	0.73	2.0	1.7	---	---	---	---
<i>Chamaesyce hirta</i>	5.9	3.1	3.4	4.1	1.2	0.34	2.4	1.3
<i>Commelina benghalensis</i>	9.5	13.1	8.8	10.5	8.7	3.7	3.8	5.4
<i>Conyza bonariensis</i>	3.5	0.82	1.5	1.9	---	---	---	---
<i>Cyperus rotundus</i>	5.3	2.4	2.9	3.5	8.7	7.8	7.9	8.1
<i>Digitaria horizontalis</i>	7.1	11.3	10.1	9.5	12.5	16.5	11.8	13.6
<i>Digitaria insularis</i>	4.1	1.8	2.8	2.9	---	---	---	---
<i>Eleusine indica</i>	9.5	28.8	19.3	19.2	8.7	6.8	6.9	7.5
<i>Emilia fosbergii</i>	4.7	1.0	1.3	2.4	1.2	0.68	4.8	2.2
<i>Euphorbia heterophylla</i>	1.2	0.05	0.28	0.51	---	---	---	---
<i>Galinsoga parviflora</i>	---	---	---	---	17.5	30.7	15.7	21.3
<i>Nicandra physaloides</i>	---	---	---	---	1.2	0.17	1.2	0.87
<i>Pennisetum americanum</i>	4.7	0.31	0.42	1.8	---	---	---	---
<i>Phyllanthus tenellus</i>	1.2	0.54	2.9	1.5	---	---	---	---
<i>Portulaca oleracea</i>	8.9	6.8	4.9	6.7	10.0	5.2	4.7	6.6
<i>Ricinus communis</i>	2.4	1.3	3.6	2.4	---	---	---	---
<i>Sida cordifolia</i>	4.7	1.2	1.6	2.5	---	---	---	---
<i>Sida rhombifolia</i>	5.9	5.0	5.3	5.4	1.2	2.4	16.9	6.8
<i>Urochloa brizantha</i>	4.7	2.4	3.3	3.5	---	---	---	---
<i>Urochloa decumbens</i>	1.2	0.10	0.56	0.62	13.7	18.2	11.8	14.6
<i>Urochloa plantaginea</i>	0.59	0.03	0.38	0.33	---	---	---	---
<i>Zea mays</i>	0.59	0.03	0.38	0.33	---	---	---	---

**Table 4.** Frequency (RF), density (RD), abundance (RAB) and relative importance (RI) of weed species in pasture *Urochloa brizantha* assessed at the beginning and the end of the rainy season, in Rio Verde - GO, Brazil, 2013

Species	Beginning of the rainy season				End of the rainy season			
	RF%	RD%	RAB%	RI%	RF%	RD%	RAB%	RI%
<i>Alternanthera tenella</i>	8.0	5.0	9.8	7.6	15.8	11.7	15.7	14.4
<i>Amaranthus viridis</i>	4.0	5.0	19.6	9.5	---	---	---	---
<i>Commelina benghalensis</i>	4.0	1.7	6.5	4.1	5.3	3.3	13.5	7.4
<i>Crotalaria incana</i>	24.0	35.0	22.8	27.3	21.0	30.0	30.3	27.1
<i>Neonotonia wightii</i>	---	---	---	---	42.1	40.0	20.2	34.1
<i>Nicandra physaloides</i>	16.0	10.0	9.8	11.9	---	---	---	---
<i>Phyllanthus tenellus</i>	1.74	0.11	0.08	0.64	---	---	---	---
<i>Sida rhombifolia</i>	36.0	35.0	15.2	28.7	15.8	15.0	20.2	17.0

In pastures located in the state of Mato Grosso do Sul, Guglieri-Caporal et al. (2010) observed that species of the Fabaceae family are among the most frequent ones, similarly to *C. incana* in this survey. In our study, the species *C.*

*incana* and *N. wightii*, which stood out in terms of RF values, also had the highest RD values (35%) and RI values (28.7 and 27.3%, respectively). In terms of RAB values, the three species with the highest values at the beginning of the rainy

season were *C. incana* (22.8%) *A. viridis* (19.6%) and *S. rhombifolia* (15.2%). At the end of the rainy season, the species *N. wightii* and *C. incana* had higher RD, RAB and RI values in pasture dominated by *U. brizantha* (Table 4).

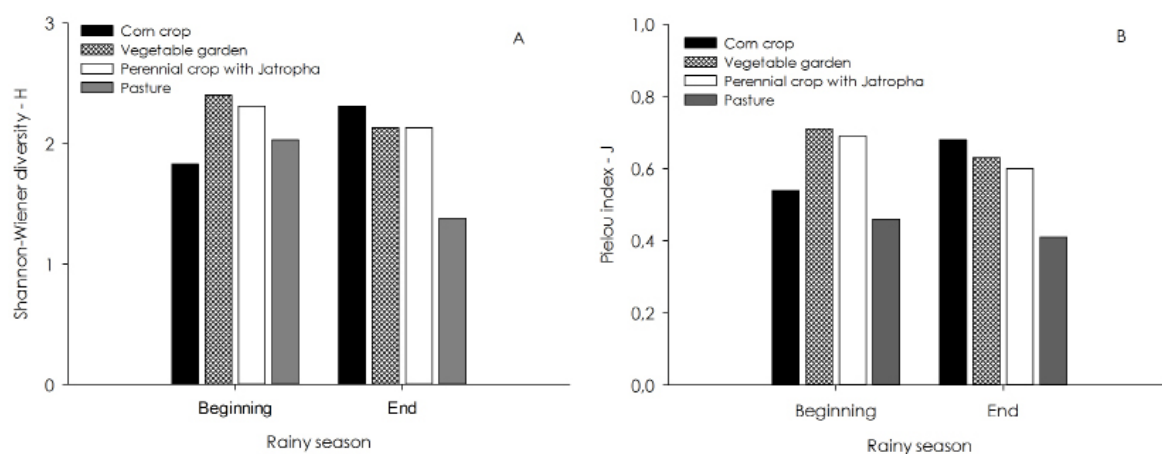
Although management practices influence the composition of weed communities, it was possible to observe that weed species of the Poaceae family was presented in various conditions, except in pastures. The seeds of species of Poaceae generally have short longevity, and in the pastures are subject to germination followed by death, due to the difficulty to overcome the dense straw layer and also by grazing by animals (Pitelli, 1998).

The lowest number of weed species in systems involving pastures in relation to other environments and the less density of individuals due to the presence of *U. brizantha* already established as forage. In studies on the soil seed bank of weeds in continuous farming systems, exclusive pastures and pastures integrated with crops, Ikeda et al. (2007) observed that cultivation systems containing perennial forage grasses (*P. maximum*, *U. brizantha*, *U. decumbens* and *Andropogon gayanus*) had lower weed seed densities and fewer weed species in the soil seed bank, compared to agro-systems cultivated with crops.

Considering RI values across different environments, it becomes evident that management procedures such as crop

rotation, no-tillage or reduced soil disturbance, intercropping with legumes and integration of crop-livestock allow to adapt or complement integrated weed management in different agro-systems. Several studies have shown the effects of management on reducing the persistence of weeds in agro-systems (Fernandes et al., 1999; Jakelaitis et al., 2003; Meschede et al., 2007; Ikeda et al 2007; Sodre Filho et al., 2008).

The Shannon-Wiener diversity is considered high when it is above 3, average between 2 and 3, low between 1 and 2 and very low less than 1 (Cavalcanti & Larrazábal, 2004). Regarding the weed diversity of the environments in the two seasons evaluated, we noted that the average species diversity at the beginning of the rainy season (2.0) was close to the average diversity found in the dry season (1.9) (Figure 1A). Diversity estimates were considered on the average for annual crop corn evaluated at the end of the rainy season and for perennial crop of the *Jatropha curcas* and vegetables garden, for both evaluated periods. The most diverse environment at the beginning of the rainy season was the horticultural crop (2.4), while at the end of the rainy season, it was the annual corn crop (2.3) (Figure 1A). Weed diversity was low for pasture, both at the beginning (1.5) and at the end (1.4) of the rainy season, and for the annual corn crop at the beginning of the rainy season (1.8) (Figure 1A).



**Figure 1.** Shannon-Wiener index - H (A) and Pielou index - J (B) for different environments determined at the beginning and the end of the rainy season, Rio Verde - GO, Brazil, 2013.

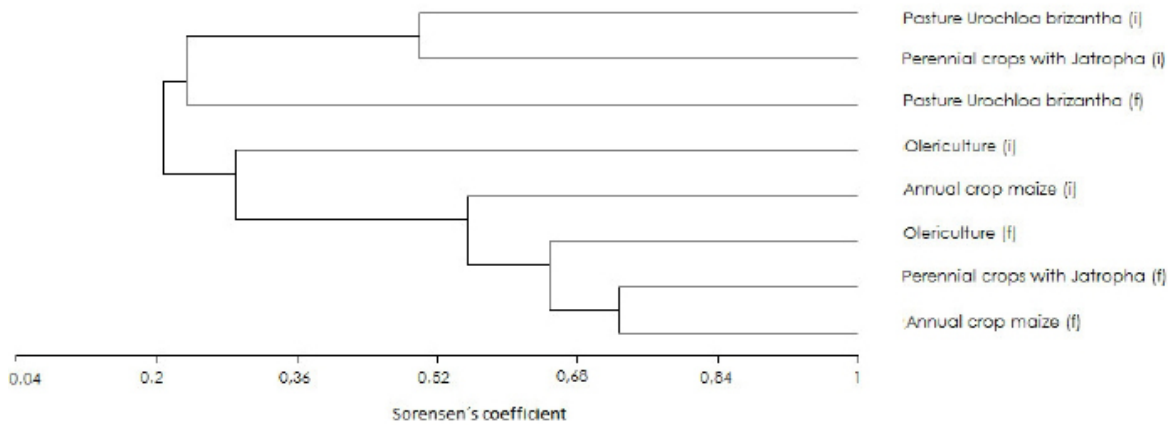
Equitability varied between 0 and 1 and is considered high if the values are above 0.5. According to Cavalcanti & Larrazábal,

(2004), low values demonstrate a dominance of one or more species in the studied community, while high equitability means uniform distribution

between species in the sample and that, despite the complexity of the community, individuals are well distributed. Our Shannon-Wiener index values are consistent with those found for the evenness Pielou index, where at the beginning of the rainy season, average evenness (0.60) was close to the average evenness at the end of the rainy season (0.58). Between environments, at the beginning of the rainy season, the largest estimate of equitability was found in the vegetable crop environment (0.71), while at the end of the rainy season, the largest equitability value was observed for the annual cultivation environment (0.68). Only pasture had a poor

uniform composition for both evaluated periods (Figure 1B).

Figure 2 shows the similarity between the evaluated environments, considering the two periods. The most similar environments are the corn crop with the perennial crop with *Jatropha curcas* at the end of the rainy season (0.73), both of which showed a similarity of 0.65 with the horticultural crop. These three environments were similar at 0.55 to the annual corn crop at the start of the rainy season, and the similarity of these environments with the horticultural crop environment was 0.29.



**Figure 2.** Similarity dendrogram of four environments determined at the beginning (i) and the end (f) of the rainy season in Rio Verde - GO, Brazil, 2013.

Sorensen's coefficient value of the pasture at the beginning of the rainy season was similar to the value of the perennial cultivation environment with *Jatropha curcas* (0.50) and both showed similarity with the pasture area found at the end of the rainy season (0.23). The first and second group had a similarity of 0.21. The similarity coefficients showed high variability, indicating a condition for the establishment of groups of the environments with a certain level of similarity, regarding the specific composition.

The cophenetic correlation coefficient (r) was 0.87, indicating an adequate adjustment between the dissimilarity matrix and the resulting matrix provided by the grouping method. However, Kuva et al. (2007) pointed out that the similarity index considers only the absence or presence of the species, failing to consider information on density, biomass and distribution pattern of the species.

Even when dealing with neighbouring

areas under the same climatic conditions, evaluation of the floristic composition showed significant patterns of variation for the phytosociological indices, diversity, equitability and similarity between different environments. These differences are related to the crop, soil management and weed control method, which are crucial for weed community composition.

### Conclusions

In the present study, the most important weed species were *A. tenella* in the corn crop; *P. maximum* and *C. hirta* in the horticultural crop; *E. indica* and *G. parviflora* in the *Jatropha curcas* crop and *S. rhombifolia* and *N. wigrtii* in pastures at the beginning and end of the rainy season, respectively.

Environments with corn, *Jatropha curcas* and horticultural crops showed higher evenness and similarity.

The pasture environment had a low



diversity and uneven distribution of individuals among species. Similarly, the environment represented by the corn crop presented lower diversity at the beginning of the rainy season.

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