PHYTOSOCIOLOGY OF WEED COMMUNITY IN CULTURE OF COWPEA (*VIGNA UNGUICULATA* L. WALP) AND CONTROLLING POSSIBILITIES WITH PRE-EMERGENT HERBICIDES

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Abstract. This study has aimed to diagnose and compare the predominant weed species in cowpea crop in the Amazon region and to evaluate the effectiveness of herbicides applied in pre-emergence. The weed sampling was obtained before planting, the cowpea cultivar was BRS Aracê, by collecting all the plants present within a 0.25 m² hollow frame, randomly thrown 40 times in experimental area to calculate the phytosociological indices. The herbicide efficiency experiment was conducted in a randomized block design with four replications, in time subdivided plot model. Treatments were applied one day after crop planting, their doses (g/ha ai) were: metribuzin (360), sulfentrazone (600), S-metolachlor (1200), pendimethalin (750), oxadiazon (1000), alachlor (2400), metribuzin + pendimethalin (360 + 750), metribuzin + alachlor (360 + 2400), manual weeding and weedy check. The evaluations of weed control were done at 21, 28 and 35 DAP. The most important weed in phytosociology was *Tridax procumbens*. Cultivation of the crop with weeds caused a reduction of more than 66% in crop productivity. The application of the metribuzin herbicide prevented the emergence of all cowpea seedlings while oxadiazon satisfactorily controlled the weeds without affecting the crop yield.
Keywords: *importance value index, chemical control, selectivity, tolerance*

Introduction

Cowpea (*Vigna unguiculata* (L.) Walp) is an annual grain legume (Fabaceae) native to west Africa, and possibly originated in Nigeria (Rachie and Roberts, 1974).

Cowpea is a widely adapted, stress tolerant grain, vegetable, and fodder crop grown on about 7 million ha in warm to hot regions of Africa, Asia, and the Americas (Yadav et al., 2017). Historically, cowpea production is made by small producers using a low technology level (Costa et al., 2017), from the North and Northeast regions of Brazil. The Brazilian average productivity of cowpea is between 300 and 400 kg/ha, considered low when compared to its productive potential (1000 kg/ha) (Mancuso et al., 2016).

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The factors contributing to the low productivity of cowpea in Brazil are mainly related to the absence of mechanization and the low investment in the control of weeds and pests (Filgueiras et al., 2009).

Therefore, one of the major problems encountered by producers in the northern region of Brazil is the interference of weeds in the crop, since sowing is done in wide spacing and the initial growth of cowpea is slow (Costa et al., 2017). The problem of weed has been reported more severe during rainy season, as weeds come in 2-3 flushes and growth is very fast, therefore, they compete for light, nutrient and space and are responsible for reduction in crop yield and productivity by up to 70% (Moody,1973).

Type of weeds, weed density, their persistence and crop management practices determine the magnitude of yield loss (Omisore et al., 2016). The identification of weeds at the level of genus and species is a basic task, constituting a fundamental instrument of phytosociological surveys that will be the basis for the knowledge of the main weeds present in a given area. The progress of phytosociological evaluations has been slow and non-isochronous in the different research groups in the country.

The critical period of crop weed competition in cowpea has been identified as 20-30 days after sowing and presence of weeds beyond this period causes severe reduction in yields (Gupta et al., 2016). Hence, weed control needs to be undertaken during initial period of crop growth.

The occurrence of weed flora under any crop production system greatly influenced by range of factors such as history of the planting area, soil seed bank, tillage operations, selection of crops, application of chemical fertilizer, irrigation and agronomic practices etc (Saved et al., 1990). Beside these, the weed control measures (Hass and Streibig, 1982) and environment factors (Schemer and Chilcote, 1969) also significantly influenced the distribution of weed flora. Therefore, it is fundamental to know the phytosociology of weeds that compete with a crop, understanding the plant communities from a floristic and structural point of view and knowing the species present in a specific area (Braun-Blanquet, 1979).

Still widely used by smallholders, manual weeding although proven effective, it is not economically viable on a large scale because of the high labor cost, so integrated weed management is the best approach to minimize weed interference and productivity losses (Kumar and Singh, 2017). The suggestion that integrated weed management can be useful to provide better weed control measures should further be assessed. Omisore et al. (2016) compared different weed control methods in cowpea production and pre-emergence herbicide + hoe weeding at 6 weeks after planting was more effective in controlling weeds and increase grain yield.

Chemical weed control, i.e. use of herbicide proved the most practical, effective and economical means of controlling even unapproachable or in accessible weed or noxious weed (Yadav et al., 2017).

There are no registered herbicides for cowpea in Brazil, which prevents recommendations, however for crops belonging to the same botanical family (Fabaceae) as common bean (*Phaseolus vulgaris* L.) and soybean (*Glycine max* L.) are registered 27 and 55 herbicides, respectively.

Another aspect to be considered in the application of herbicides in this crop is the lack of knowledge about the tolerance of the many varieties to the herbicides (Harrison and Fery, 1993). There is great variability in the tolerance of cowpea genotypes to herbicides such as bentazon, in which more susceptible genotypes were killed, or very affected, with applications of 2000 g ai ha^{-1}, while the most tolerant ones resisted at the dose of 16.000 g ai ha^{-1} (Harrison and Fery, 1993).

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Study the selectivity of herbicides to this culture is promising because the chemical control ensure less dependence on labour, efficiency even during the rainy season, effectiveness in controlling weeds in the planting furrow and not affecting the root system of the crops and being efficient in controlling vegetative propagation in the weeds (Costa et al., 2017). Herbicides already available in the Brazilian market, especially those used in common bean and soybean crops, can be effective for the control of weeds in cowpea, without causing injury or yield losses,.

The aim of this study was to get to know the characteristics of the characteristics of weed community of cowpea crop in the Amazon region of northern Brazil and to evaluate the selectivity and efficiency of herbicides applied in pre-emergence in cowpea crop.

Materials and methods

The experiment was conducted in the Agricultural Sciences Center of Federal University of Roraima, Cauamé Campus, municipality of Boa Vista in the State of Roraima, latitude 2°52’15.49” N, longitude 60°42’39.89” W and 85 m of altitude, with annual average precipitation of 1.678 mm (Araújo et al., 2001).

The soil of the experimental area was classified as Yellow Udox Soil and based on interpretation of chemical analysis, the soil was fixed using 1.500 kg/ha of limestone, 50 kg/ha of FTE BR 12, 90 kg/ha of P_2O_5 in the form of simple superphosphate and 60 kg/ha of K_2O in the form of potassium chloride.

Weed collection was performed immediately before planting, by the square inventory standard method. A 0.25 m^2 square was used, which was randomly launched for 40 times in the usable area. All weeds that were contained in the square were collected with root system and aerial part.

The collected species were identified and quantified according to family, genus and species by analysis of the external morphological characteristics of the vegetative and reproductive plant parts, according to literature, by comparison with other species identified and also by consulting experts.

The floristic list with families and species was organized according to the classification system established in the Angiosperm Phylogeny Group III guidelines (APG III, 2009). All scientific names and their authors were confirmed after verification in the International Plant Names Index (IPNI, 2013).

Phytosociological structure was assessed based on parameters such as the relative values of frequency, density and abundance and the importance value for each species according the methodology proposed by Braun-Blanquet (1979) (*Table 1*).

Table 1. *Description of the evaluated characteristics, formulas and evaluation method for the phytosociological survey based on the methodology proposed by Braun-Blanquet (1979)*

Characteristics	Method
Frequency (F)	Number of releases that contain the species/Total number of releases
Density (D)	Total number of individuals per species/Total area collected
Abundance (A)	Total number of individuals per species/Nº of releases that contain the species
Relative frequency (RF)	(Species frequency x 100)/Total frequency of all species
Relative density (RD)	(Species density x 100)/Total density of all species
Relative abundance (RA)	(Species abundance x 100)/Total abundance of all species
Importance value (IV)	RF + RD + RA

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The seeds of the BRS Aracê cowpea variety, used in this study, were inoculated with the *Bradyrhizobium* BR 3262 strain recommended for the state of Roraima. The soil management system of the area was no-tillage, with sowing done with a mechanized planter at a spacing of 0.5 m between rows and planting density of 10 seeds per linear meter.

The experiment was designed in randomized blocks with 4 replicates in the time subdivided plot model. The plots consisted of herbicides applied in pre-emergence (*Table 2*) and the subplots consisted of 3 evaluation periods with a 7-day interval between them (21, 28 and 35 days after emergence). Pre-emergent herbicides, registered for the cultivation of soybeans and common bean, were used, in addition to some mixtures, except oxadiazon (registered for some horticultural crops, rice and sugar cane). These herbicides, although presenting different mechanisms of action, presented some degree of selectivity to other varieties of cowpea or to soy or bean crops.

Table 2. *Herbicides used in pre-emergence as a strategy to control weeds in cowpea, their modes of action, crops for which they are registered in Brazil, Boa Vista-RR, 2016*

	Pre-emergent herbicides	**Mode of action**	**Crop (Fabaceae)**	**Dose ($g\ ha^{-1}$ a.i.)**
T1	Metribuzin	Selective, systemic with contact and residual activity. Inhibits photosynthesis (photosystem II)	Soybeans	360
T2	Sulfentrazone	Cell membrane disruption - PPO inhibitor	Soybeans	600
T3	S-metolachlor	Selective, absorbed through roots and shoots. Inhibition of VLCFA (inhibition of cell division)	Soybeans; Common bean	1200
T4	Pendimethalin	Selective, absorbed by roots and leaves. Inhibition of mitosis and cell division. Microtubule assembly inhibition	Soybeans	750
T5	Oxadiazon	Selective with contact action. Inhibits protoporphyrinogen oxidase, leading to irreversible cell membrane damage	-	1000
T6	Alachlor	Selective, systemic action absorbed by germinating shoots. Inhibition of VLCFA (inhibition of cell division)	Soybeans, Peanuts	2400
T7	Metribuzin +Pendimethalin	Inhibits PSII+ Microtubule assembly	Soybeans	360+750
T8	Metribuzin+ Alachlor	Inhibits PSII+Inhibition of VLCFA	Soybeans	360+2400
T9	Weed-free (manual weeding)	-	-	-
T10	Weedy check	-	-	-

The experimental plot consisted of six rows with 5 m of length, however, it was considered useful area of the plot the two central rows. The two lateral rows in addition to 0.5 of the frontal ends of the plot were considered border. The total area of the experiment was 600 m^2 and the total useful area was 200 m^2.

The herbicides were applied one day after planting and a costal spray, equipped with two TT 110.02 nozzles, spaced 0.5 m, maintained at a pressure of 2 bar, and a syringe volume of 170 L/ha was used.

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The evaluation of control efficiency at 21, 28 and 35 days after planting (DAP) was based on a visual scale recommended by the Brazilian Society of Weeds. Percentage notes were assigned from 0 to 100%, where 0 (zero) indicates the absence of control and 100 the total control of weeds.

The results were submitted to the normality test of Shapiro-Wilk, visual control rating data were arc-sine square root transformed prior to analysis. Back-transformed are presented with mean separation based on transformed values. Data were subjected to ANOVA, when the variances were significant, the means were compared by the Tukey test at $p \leq 0.05$, using the software R™ version 2.12.2 and the package ExpDes english (R Core Team, 2017).

Results

This weed community was represented by 29 weed species from 10 different botanical families, 34.5% were monocots and 65.5% were dicots. *Table 3* shows the weed species found in the area and their respective common names and EPPO codes subdivided into botanical families.

Table 3. *Weed species found in the area with their common names and EPPO codes, distributed by botanical families*

Botanic family	Scientific name	Common name	EPPO code[1]
Asteraceae	*Acanthospermum australe* (Loefl.) Kuntze	Paraguayan starbur	ACNAU
	Emilia coccinea (Sims) G. Don	Scarlet tasselflower	EMICO
	Emilia sonchifolia (L.) DC. ex Wight	Lilac tasselflower	EMISO
	Praxelis clematidea (Griseb.) R.M.King and H.Rob.	Praxelis	PRACL
	Tridax procumbens L.	Coat buttons	TRQPR
Fabaceae	*Chamaecrista conferta* (Benth.) H. S. Irwin and Barneby	Pig’s senna	CASAB
	Desmodium tortuosum (Sw.) DC.	Florida beggar weed	DEDTO
	Indigofera hisurta L.	Hairy indigo	INDHI
	Mimosa candolei R. Grether	Sensitive plant	SCNLE
	Zornia latifólia Sm.	Zornia	ZORLF
	Chamaecrista hispidula (Vahl) H.S.Irwin and Barneby	Cassia	CASHP
	Calopogonium mucunoides Desv.	Wild ground nut	CLOMU
Poaceae	*Cenchrus echinatus*L.	Southern sandbur	CCHEC
	Digitaria horizontalis Willd.	Jamaican crabgrass	DIGHO
	Digitaria insularis (L.) Fedde	Sourgrass	TRCIN
	Digitaria sanguinalis (L.) Scop.	Common crabgrass	DIGSA
	Paspalum dilatatum Poir.	Dallisgrass	PASDI
	Brachiaria decumbens Stapf. Prain.	Signal grass	BRADC
Cyperaceae	*Cyperus ferax* L.	Flatsedge	CYPFE
	Cyperus flavus (Vahl) Nees	Inflatedscale flatsedge	CYPFW
	Cyperus rotundus L.	Nutgrass	CYPRO
Malvaceae	*Waltheria indica* L.	Indian waltheria	WALAM
Convolvulaceae	*Ipomoea nil* (L.) Roth	Japanese morning glory	IPONI
Commelinaceae	*Commelina benghalensis* L.	Bengal day flower	COMBE
Amarantaceae	*Amaranthus viridis* L.	Slender amaranth	AMAVI
	Alternanthera tenella Colla	Perrotleaf	ALRFI
Nictaginaceae	*Boerhavia diffusa* L.	Red spiderling	BOEDI
Euphorbiaceae	*Chamaesyce hirta* (L.) Mills.	Hairy spurge	EPHHI
	Chamaesyce hyssopifolia (L.) Small	Hyssop spurge	EPHHS

[1]EPPO code: also known as Bayer code, is an encoding system used by the European and Mediterranean Plant Protection Organization (EPPO) to designate plants, pests and pathogens that are important for agriculture, 2014

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The botanical families with the highest number of species were Fabaceae, Poaceae and Asteraceae with 7, 6 and 5 species, respectively, representing 62% of the weed species found in the studied area. There is a high number of weed species in the area belonging to the same botanical family of cowpea (Fabaceae).

Table 4 shows the phytosociological parameters (RF, RD, RA and IV) of weed species found in the experimental area. For the values of relative density, there are 5 prominent species: *Tridax procumbens* (21.21%), *Praxelis pauciflora* (13.26%), *Digitaria insularis* and *Digitaria sanguinalis,* (10.23% both) and *Chamaesyce hirta* (9.47%). The other species showed relative density (RD) lower than 5%.

Table 4. *Phytosociological parameters (RF, RD, RA and IV) of weed species found in the experimental area*

Species	RD	RF	RA	IV
Acanthospermum australe	1.89	9.71	2.32	13.92
Alternanthera tenella	4.17	2.18	6.8	13.15
Amaranthus viridis	1.52	2.18	2.47	6.17
Boerhavia diffusa	0.38	0.73	1.86	2.96
Brachiaria decumbens	1.52	2.18	2.47	6.17
Calopogonium mucunoides	0.38	0.73	1.86	2.96
Cenchrus echinatus	2.65	3.64	2.6	8.89
Chamaecrista conferta	0.38	0.73	1.86	2.96
Chamaecrista hispidula	0.38	0.73	1.86	2.96
Chamaesyce hirta	9.47	8.01	4.22	21.7
Chamaesyce hyssopifolia	1.52	1.46	3.71	6.68
Commelina benghalensis	3.03	2.91	3.71	9.65
Cyperus ferax	0.76	1.46	1.86	4.07
Cyperus flavus	0.38	0.73	1.86	2.96
Cyperus rotundus	1.52	0.73	7.42	9.66
Desmodium tortuosum	2.65	4.37	2.16	9.19
Digitaria horizontalis	1.89	2.18	3.09	7.17
Digitaria insularis	10.23	12.38	2.95	25.55
Digitaria sanguinalis	1.14	1.46	2.78	5.38
Emilia coccinea	10.23	6.55	5.57	22.35
Emilia sonchifolia	1.89	1.46	4.64	7.99
Indigofera hisurta	0.38	0.73	1.86	2.96
Ipomoea nil	0.38	0.73	1.86	2.96
Mimosa candolei	0.38	0.73	1.86	2.96
Paspalum dilatatum	2.27	0.73	11.13	14.13
Praxelis clematidea	13.26	12.38	3.82	29.46
Tridax procumbens	21.21	12.38	6.11	39.7
Waltheria indica	2.27	3.64	2.23	8.14
Zornia latifólia	1.89	2.18	3.09	7.17

The species *T. procumbens, P. pauciflora* and *D. insularis* stand out for their high frequency in the study area, as well as *Acanthospermum australe* and *C. hirta*.

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Paspalum dilatatum showed the highest value of relative abundance (11.13%) followed by *Cyperus rotundus* (7.42%) and *Alternanthera tenella* (6.80%).

From the values of relative density, frequency and abundance the importance value index (IV) was calculated and it is possible to observe in the results the prominence of 5 species, *Tridax procumbens*, *Praxelis pauciflora*, *Digitaria insularis*, *Emilia coccinea* and Chamaesyce hirta, considering the most important with IV of the order of 39.7%, 29.46%, 25.55% 22.35% and 21.70%, respectively. The other species belong to groups that present important value indices ranging from intermediate to low.

Although studies suggest that the best strategy for weed management is the application of pre-emergence herbicides and manual weeding 40 days after planting (Yadav et al., 2015), it was decided to only apply pre-emergence herbicides with the intention of reducing manual labor costs.

Table 5 shows the efficiency of the pre-emergence herbicides applied to control the weed community of cowpea in the Amazon region. There was a significant interaction between the herbicide used and the weed control efficiency at different evaluation times after application

Table 5. *Herbicides efficiency (%) in weed control at 21, 28 and 35 days after planting of cowpea and grain yield (kg/ha)*

Herbicides (H)	**Days after planting (DAP)**			**Yield (kg/ha)[2]**
	21	**28**	**35**	
	Weed control efficiency (%)[1, 2]			
Metribuzin	92.5 Aa	88.7 ABa	91.2 ABa	0.00 D
Sulfentrazone	81.2 ABa	75.0 BCa	80.0 ABCa	617.53 C
S-metolachlor	68.7 BCa	45.0 DEb	52.5 DEb	1315.52 B
Pendimethalin	45.0 DEab	40.0 DEb	52.5 DEa	1436.92 B
Oxadiazon	77.5ABa	57.5 CDb	77.5 ABCa	1668.93 A
Alachlor	52.5 CDEa	50.0 DEa	60.0 CDa	1377.16 B
Metribuzin +Pendimethalin	67.5 BCDa	55.0 CDEb	42.5 DEc	395.79 C
Metribuzin+ Alachlor	86.2 ABa	86.2 ABa	76.2 BCa	559.89 C
Weed-free (manual weeding)	100.0 Aa	100.0 Aa	100.0 Aa	1681.62 A
Weedy check	35.0 Ea	32.5 Ea	30.0 Ea	565.90 C
CV%	21.93%			8.21%
F(H)	25.85**			13.27**
F(DAP)	14.12**			-
F(HxDAP)	4.41**			-

[1]Data were arc-sine transformed before analysis; however, back-transformed actual mean values are presented based on the interpretation from the transformed data
[2]Means followed by the same letters, lowercase in the rows and uppercase in columns, do not differ significantly by Tukey's test ($p < 0.05$); **Significant at $p \leq 0.01$ by the F-test

Cowpea grain yield was significantly reduced by weed interference (565.90 kg/ha), evidencing the low competitive capacity of the crop. the treatment without weed control when compared to the treatment maintained under manual weeding, which obtained the highest recorded productivity (1668.93 kg/ha), was responsible for a loss equivalent to 66.09%.

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The herbicides Metribuzin, Sulfendrazone, Oxadiazon and the mixture of Metribuzin with Alachlor showed, until 35 days after sowing the cowpea, weed control efficiency means higher than 75%.

The application of the metribuzin herbicide prevented the emergence of all cowpea seedlings resulting in no grain yield and the mixture of metribuzin with Alachlor or Pendimethalin caused enough crop injury to reduce yields by 66.45% and 76.28%, respectively. These crop yield reductions are superior to the loss caused by weed competition in the treatment without control of the infestation (66.09%). Sulfentrazone reported control results of weed plants (80% at 35 DAP) similar to the herbicide metribuzin, causing severe injury and loss of cowpea productivity compared to weed-free treatment (62.99%).

The herbicide oxadiazon presented a good result in relation to weed control (77.5%), without affecting crop yield.

The herbicides S-metolachlor and Pendimethalin showed good crop yields (1315.52 kg/ha and 1436.92 kg/ha), although not very good weed control efficiency (52.5% for both). The other herbicides tested were statistically placed in intermediate groups regarding weed control efficiency and weedy check plots presented the worst results, being used as a parameter to evaluate herbicides with less efficiency of weed control (Alachlor and the Metribuzin + Pendimethalin mixture) (*Table 5*).

Discussion

The greater infestation of dicots in cowpea compared to monocots was also observed by Batista et al. (2017) and the fact that these weeds belong to the same class of cowpea makes their control, especially the chemical, difficult.

Several authors have highlighted the predominance of Fabaceae, Poaceae and Asteracerae families in the Amazon region, especially in agricultural areas. Marques et al. (2010), while evaluating the floristic composition of weeds in the cowpea culture in the mulch system, verified that the Cyperaceae, Fabaceae, Poaceae, Malvaceae, Asteraceae and Rubiaceae families were the ones presenting the highest number of species and greatest importance. Leal et al. (2006) studying the seed bank in systems of production of agriculture with burning and without burning in the State of Pará, also cited these families as predominant in the area and highlighting their aggressive potential in the Amazon region.

There is a high number of weed species in the area belonging to the same botanical family of cowpea (Fabaceae). Although the relationship between competition between plants and phylogenetic proximity is unimportant in comparison to competitive capacity and functional characteristics of plants, such as height, for example (Cahill et al., 2008), weed species belonging to the same family have botanical characteristics and nutritional requirements similar to those of the crop, which can make them aggressive competitors in the agricultural environment

Tridax procumbens, Praxelis pauciflora, Digitaria insularis, Digitaria sanguinalis and *Chamaesyce hirta* were the species that had higher relative density (RD). According to Swanton et al. (2015), the time of weed emergence relative to the crop is the most important factor in the crop-weed competition, with the density of weed seedlings being the second major variable. There is a relationship between weed density and duration of interference. The length of a critical period for weed control varies with density just as density thresholds vary with time of weed emergence relative to the crop (Dunan et al., 1995).

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Frequency (F) is the proportion of sampling units (e.g., quadrat; field) that contains the species. *Tridax procumbens, Praxelis pauciflora, Digitaria insularis, Acanthospermum australe* and *Chamaesyce hirta* stand out for their high relative frequency (RF) in the study area. Recording frequency is fast and nondestructive is less prone to incorrect estimates than density. In situations where appropriate sampling techniques are employed and sampling points are uniformly distributed across the sampled area, frequency can be a good indicator of the spatial distribution of a species within the sampled area (Nkoa et al., 2015)

The species with the greatest abundance (RA) were *Paspalum dilatatum, Cyperus rotundus* and *Alternanthera tenella.* Abundance measures the quantitative significance of a species in its habitat. It describes the species' success in terms of numbers. High relative abundance is related to the appearance of weeds in reeds, and it is fundamental to indicate local actions to control weeds not only in cowpea but also in crops in general (Dias et al., 2007).

The importance value index (IV) was calculated from the values of relative density, frequency and abundance. The IV groups the parameters mentioned above and classifies each species in the weed community according to its ability to cause damage and reduce the productivity of cowpea. The IV groups the parameters mentioned above and classifies each species in the weed community according to its ability to cause damage and reduce the productivity of cowpea (Concenço et al., 2013). *Tridax procumbens, Praxelis pauciflora, Digitaria insularis, Emilia coccinea* and *Chamaesyce hirta* were considered the 5 most important species of the studied area.

In their studies, Kissmann and Groth (1999) also emphasized the importance of the species *T. procumbens,* which, in addition to high relative density and relative frequency, also shows concentration of individuals in specific areas, as shown by the high relative abundance. The IV of this species reveals its competitive potential in relation to the crops. *T. procumbens* is an annual herbaceous species propagated by seeds and should be controlled in the early stages of development or by the use of pre-emergent herbicides. *P. pauciflora* presented the second highest IV, it is an annual herbaceous species and often forms dense populations due to the ease of germination and high potential for spread of seeds which are easily transported by wind.

D. insularis is an annual species and reproduces by seeds and rhizomes. Jakelaitis et al. (2003) emphasize its importance, mainly due to its habit of overgrown growth, which besides competing for area, water and nutrients, can exceed the plants of cowpea in height, harming its development. It is also worth mentioning that its habit of growth facilitates the development of pests and diseases in cowpea. The species *E. coccinea* and *C. hirta* are annual herbaceous plants propagated by seeds and should also be considered important when thinking about weed control to maintain good productivity levels of cowpea.

Due to the short cycle, cowpea becomes extremely susceptible to competition with weeds, especially at the beginning of their development (Lamego et al., 2011). The phytosociological study was done before planting the cowpea to know the local weed community and then defining a weed control strategy.

Although studies suggest that the best strategy for weed management is the application of pre-emergence herbicides and manual weeding 40 days after planting (Yadav et al., 2015), it was decided to only apply pre-emergence herbicides with the intention of reducing manual labor costs.

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Cowpea grain yield was significantly reduced by weed interference. In other field experiments, yield reductions reach 90% (Freitas et al., 2009) in the absence of weed control. Untreated weed treatment presented average productivity comparable to treatments that used nonselective herbicides, so interference from competition for essential factors equates to damage caused by the phytotoxicity of the applied products. Pre-emergent herbicides with prolonged residual effect have been used as an effective strategy to control weeds during the critical period of competition with the crop (Monquero et al., 2008).

The herbicide metribuzin is not selective for cowpea and in field experiments the cowpea presented marginal tolerance to the herbicide presenting severe injuries and drastic yield reduction. (Costa et al., 2017). Although promising results for selectivity of cowpea to sulfentrazone (Costa et al., 2017), the use of this herbicide drastically decreased the productivity of the crop in this study, this behavior may be due to the dosage of the sulfentrazone applied or the variety of cowpeas used, since it is known that sulfentrazone can cause phytotoxicity to cowpea in high doses as there is a difference in the effect of the herbicide between the cultivars (Azevedo et al., 2016). For varieties with lower tolerance to sulfentrazone, growers need to ensure the quality of application in relation to soil type and pH, otherwise the herbicide may present phytoxicity.

The herbicide oxadiazon presented a good result in relation to weed control without affecting crop yield. Fontes et al. (2010) obtained similar weed control (82%) in the Amazon region without affecting the BRS Guariba variety using the 600 g ia. ha^{-1} dose. Oxadiazon has as its mechanism of action the inhibition of the enzyme protoporphyrinogen oxidase (PPO) e and when applied in pre-emergence of weeds, phytotoxic actions occur during emergence of seedlings, close to the soil surface in a 0-5 cm depth range. Fontes et al. (2010) obtained similar weed control (82%) in the Amazon region without affecting the BRS Guariba variety using the 600 g ia. ha^{-1} dose. Oxadiazon has as its mechanism of action the inhibition of the enzyme protoporphyrinogen oxidase (PPO) e and when applied in pre-emergence of weeds, phytotoxic actions occur during emergence of seedlings, close to the soil surface in a 0-5 cm depth range (Silva et al., 1999).

Conclusion

Tridax procumbens, *Praxelis pauciflora*, *Digitaria insularis*, *Emilia coccinea* and *Chamaesyce hirta* were the species with the highest index of importance (IV) in the Amazonian cowpea area, difficult to control plants with high reproductive rates, these weeds play aggressive competition with cowpea plants for environmental resources and need to be controlled in the early stages of their development, so the use of pre-emergent herbicides are recommended as a control strategy.

Weed competition severely reduces cowpea productivity. The herbicides metribuzin, sulfentrazone and oxadiazon were satisfactory levels of weed control; however, the use of metribuzin resulted in no yield of the culture, preventing its germination. The sulfentrazon, which is considered selective for cowpea beans, significantly reduced the yield of the crop under the tested conditions and variety. The use of oxadiazon in pre-emergence was an effective strategy for weed control up to 35 DAP without reducing crop yield.

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