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PRODUÇÃO VEGETAL

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PADRÃO DE ATIVIDADE ALELOPÁTICA EM POÁCEAS E FABÁCEAS

RESUMO: Visando determinar e caracterizar a atividade alelopática em função das espécies fabáceas e poáceas, da fração da planta e sensibilidade da planta receptora, coletaram-se folhas e raízes de poáceas e fabáceas em Belém-PA. O potencial da atividade alelopática foi testado sobre a germinação de sementes e alongamento da radícula e hipocótilo utilizando *Mimosa pudica* e *Senna obtusifolia* como receptoras, em delineamento inteiramente casualizado, com três repetições. Os valores de inibição da germinação, alongamento do hipocótilo e da radícula foram analisados por modelo linear geral, testados via teste F e, quando significativos, comparados pelo teste de Tukey a 5% de probabilidade, sendo classificados como inibição efetiva ($p<0,001$) e potencial (pelos componentes das espécies, $p<0,05$). Os efeitos de poáceas e fabáceas sobre a germinação das sementes, alongamento de radícula e hipocótilo de *M. pudica* não foram significativos, enquanto a germinação em *S. obtusifolia*, bem como o alongamento do hipocótilo foram menores sob extratos das fabáceas. As espécies estudadas não apresentaram comportamento semelhante em relação aos efeitos alelopáticos. Houve tendência das frações folha apresentarem maior efetividade inibitória e, de acordo com a análise multivariada dos cinco agrupamentos, os grupos fração folha de *Calopogonium mucunoides* e *Enterolobium* sp e ambas as frações para o grupo *Canavalia*

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ensiformis foram os inibidores em maior magnitude. De forma geral, pode-se considerar que as fabáceas apresentaram maior potencial alelopático.

PALAVRAS-CHAVE: plantas de cobertura, bioensaios de germinação, plantas daninhas.

PATTERN OF ALLELOPATHIC ACTIVITY ON POACEAE AND FABACEA

ABSTRACT: Leaves and roots of Poaceae and Fabaceae were collect in Belém, PA in order to determine and characterize the allelopathic activity depending on the Fabaceae and Poaceae species from the fraction of the plant and sensitivity of the receiving plant . The potential of the allelopathic activity was tested on seed germination and elongation of radicle and hypocotyl using *Mimosa pudica* and *Senna obtusifolia* as recipients in a completely randomized design with three repetitions. The values of germination inhibition, elongation from the hypocotyl and radicle were analyzed by general linear model, tested via the F test, and when significant, compared by the Tukey at 5% probability, being classified as effective inhibition ($p < 0.001$) and potential inhibition (by the components of the species, $p < 0.05$). The effects of Poaceae and Fabaceae on the seed germination, radicle elongation and hypocotyl from *M. pudica* were not significant, while the germination in *S. obtusifolia* and the elongation of the hypocotyl were lower in extracts of Fabaceae. The studied species did not show similar behavior regarding the allelopathic effects. There was a trend of leaf fractions presenting higher inhibitory effectiveness, and according to the multivariate analysis of the five groupings, the leaf fraction groups from *Calopogonium mucunoides* and *Enterolobium sp* and both fractions of *Canavalia ensiformis* group have been inhibitors at higher magnitude. In general, one can consider that Fabaceae showed highest allelopathic potential.

KEYWORDS: plants of coverage, germination bioassays, weed

INTRODUCTION

The development of agricultural activity in tropical areas is limited by the appearance of weed populations, which are characterized by the extensive botanical diversity and the extreme aggression. In many agricultural areas, these plants are a major component of maintenance costs of the activity, with special emphasis on areas of cultivated pastures. In certain models of farming exploitation, notably in those where the soil gets uncovered for a certain period of time, the occurrence of weeds is more frequent and more problematic. Considering that the environmental conditions in the tropics are favorable to the biomass production, it is possible to maximize the

development of cover species and the benefits arising from their use. The use of cover species allows the reduction of erosion, nutrient cycling, increased levels of soil organic carbon, improved temperature and humidity conditions for the implementation of subsequent cultures, among others.

Several studies performed in Brazil showed the potential of species coverage to supress the weeds development (ERASMO et al., 2004; TREZZI and VIDAL, 2004; TOKURA and NÓBREGA, 2004; TOKURA and NÓBREGA, 2005; RIZZARDI et al., 2006; TOKURA and NÓBREGA , 2006, BORGHI et al., 2008; MONQUERO et al., 2009; NÓBREGA et al., 2009; MAULI et al. 2011, ROSA et al., 2011). The weed emergence suppression by soil cover is attributed to physical factors such as the availability of solar radiation (FACELLI and PICKETT, 1991; THEISEN and VIDAL, 1999) and reduction of thermal amplitude in the superficial layer of the soil (TEASDALE and MOHLER, 1993; THEISEN and VIDAL, 1999). Additionally, in the last decades has been suggested the possibility of the cover plants to produce and release chemical substances to the environment, which interfere with factors related to the dynamics of these species as the germination and development of weeds, affecting enormously the competitive potential.

The release of these compounds by plants occurs by leaching processes and volatilization of live or dead tissues, radicular exudation, and also during the decomposition process of tissues (SOUZA, 1988; RODRIGUES et al., 1993; WEIDENHAMER, 1996).

To generate basic information on the allelopathic properties of plants in use or with potential for green cover is of fundamental importance to establish strategies to improve the role of allelopathy in the actual farm operating models. However, the level of information accumulated about the species coverage is still limited. It is important to evaluate the actual role of these species by comparing them with the help of methodologies that standardize, for example, means of acquiring the extracts and the concentration to be used. It is also important the standardization of methodologies in order to evaluate the allelopathic responses in the target species. This will allow evaluating more precisely the coverage species, distinguishing them according to their allelopathic potential.

In this context, this work aimed at determining and characterizing the pattern of the allelopathic activity depending on the donor species Fabaceae and Poaceae from the fraction of the plant and sensitivity from the receptor plant.

MATERIAL AND METHODS

Vegetal material collection: leaves and roots of Poaceae species *Brachiaria brizantha, B. decumbens, B. humidicola and Paspalum maritimum* and from the Fabaceae species *Calopogonium mucunoides, Canavalia ensiformis, Desmodium ovalifolium, Enterolobium maximum, Enterolobium sp., Inga edulis, Pueraria phaseoloides* and *Stylosanthes guianensis* were collected at the Experimental Field of Embrapa Amazônia Oriental, located in Belém, PA. During collection, plants were in vegetative development. Subsequently, the two fractions were dried in greenhouses of forced air circulation at 40 ^{0}C to constant weight. They were then crushed in a knife type mill.

To the extraction was used mixture of water and methanol in the proportion of 7:3, using 3.0 L of solution per kg of crushed dry material for the period of seven consecutive days, replacing the solution daily by others 3.0 liters. Afterwards, solution was removed on a rotary evaporator to yield, thus, the concentrated hydroalcoholic crude extract from respective fractions of each species.

Receptor species: *Mimosa pudica* and *Senna obtusifolia* were used. The seeds were collected in areas of cultivated pastures in the process of degradation in the town of Terra Alta (PA). They went through a cleaning process and overcoming dormancy by immersion in concentrated sulfuric acid for 15 (*Mimosa pudica)* and 20 minutes (*Senna obtusifolia*).

Bioassay of seeds germination: the germination was monitored for 10 days with daily counting and elimination of the germinated seeds, whose germination criterion was the presentation of primary root length equal to or greater than 2 mm (JUNTILA, 1973; DURAN and TORTOSA, 1985). The tests were carried out in BOD type chambers at constant temperature of 25 °C and 12 h photoperiod. Each Petri dish of 9.0 inches in diameter was covered with a sheet of quality filter paper and received 30 seeds.

Bioassay of the radicle and hypocotyl elongation: the tests were carried out in BOD type chambers under controlled conditions at 25 °C of constant temperature and 24 h photoperiod. Each Petri dish was lined with filter paper and received three pre-germinated seeds two days after the radicle protrusion at 2 mm. At the end of 10 days of growth were measured the lengths of the root and hypocotyl.

For all tests, 1.0% concentration was used by adding a volume of 3.0 mL into each Petri dish allowing evaporating the solvent and adding

distilled water to a volume corresponding to that evaporated. The tests solutions were added only once at the bioassay beginning, and from then added distilled water only when necessary.

Experimental lineation and statistical analysis: it was used the completely randomized experimental lineation with three replications, using distilled water as control. The values of germination inhibition ($d_{(g)}$) of the hypocotyl elongation of the ($d_{(h)}$) and of the radicule ($d_{(r)}$) of the receptor species in each extracts from the fractions of the covering species were analyzed through the general linear model (GLM) [1], consisting of the effect from the species and fractions, as well as the interaction between them. The model was tested through the F test, and if significant, the mean values were compared according to the Tukey test both at 5% of error probability.

The inhibition of germination, elongation of the hypocotyl and radicle in each one of the extracts from the fractions of the species were classified as: (i) effective inhibition - superior limits of confidence breaks of 95% of the mean equal to or greater than 50%; (ii) inhibiting potential - superior limits of confidence breaks of 95% from the mean equal to or greater than 35%.

The difference between the average inhibition of germination and development of the hypocotyl and radicle among receptor species on each one of the extracts of the species fractions was evaluated by the t test. The specificity of inhibition of a given fraction of the species in relation to species-model was considered depending on a significant difference between their mean values being classified as: (i) effective specificity - statistical difference highly significant ($p < 0.001$), (ii) specificity by the components of the species - statistically significant difference ($p < 0.05$).

RESULTS AND DISCUSSION

Comparative analysis of average effects promoted by Fabaceae and Poaceae

The statistical analysis for comparative effects between Fabaceae and Poaceae (Table 1) indicates no difference ($p > 0.05$) for the effected inhibition on the receptor species *Mimosa pudica*, while for *Senna obtusifolia*, superiority ($p < 0.05$) from the Poaceae was observed on seed germination, and from the Fabaceae to the effects on radicle elongation, with no difference ($p > 0.05$) between the two families, to

the effect on the hypocotyl elongation. When considering the effects on the two receptor species, higher specificity from Fabaceae and Poaceae to inhibit the germination and radicle elongation of *Mimosa pudica* than from *Senna obtusifolia* is observed.

Species of the families Fabaceae and Poaceae have proven to be promising as a source of chemicals with phytotoxic activity, especially for use in the weed management, as can be observed in the works of Lôbo et al. (2008 and 2010), Tokura and Nóbrega (2006), Nasir et al. (2005), Kato-Noguchi (2003) and Bertin et al. (2003), among others. Expressive variations in the intensity of the effects between the different species are attributed to factors such as concentration and specificity between the donor and receptor species.

Table 1 Comparative analysis of the potential allelopathic effects promoted by the two studied families

Family	Receptor species	
	Malice	Forest pasture or obtusifolia
	Seeds germination (%)	
Fabaceae	28.46A	18.00 B
Poacea	29.63A	24.79A
	Radicle elongation	
Fabaceae	35.54A	30.67A
Poacea	32.58A	25.17 B
	Elongation of the hypocotyl	
Fabaceae	16.31A	13.21A
Poacea	18.13A	15.67A

Means followed by the same letters, in the column, do not differ by the Tukey test at 5% probability.

The percentage of germination in seeds of obtusifolia and the hypocotyl elongation were lower in extracts of Fabaceae. However, the Fabaceae presented less effect on the radicule elongation.

When comparing the inhibitory effects of individuals, there are variations in the pattern of both allelopathic activity upon the germination such as in the elongation of the radicule and hypocotyl from malicia (Table 2) and mata-pasto (Table 3). Among the Fabaceae, *Enterolobium sp*. was the species with the greatest potential to inhibit the germination and elongation of the radicule and hypocotyl from the malicia species. Among the Poaceae, *P. maritimum* and *B. brizantha* (Table 2) have stood out.

For the effects over mata-pasto (Table 3), there is a greater potential for *Calopogonium mucunoides* affecting the seed germination, and *C. ensiformis* affecting the elongation of the radicule and hypocotyl among the Fabaceae, and *P. maritimum*, among the Poaceae. Whereas the value of 50% of inhibition (DUDAI et al., 1989) as satisfactory for this type of study is shown in Tables 2 and 3, only *C.ensiformis* and *E. sp.* in global terms, reached this index, and only when was analyzed the effects on the radicule elongation of the two receptor species.

Overall, the results showed a clear tendency of the leaf fractions presenting higher inhibitory effectiveness, independently of the analyzed factor and from the donor species (Table 2 and 3 and Figure 1). However, for some species, the root fraction has presented higher phytotoxic effect. This effect is especially marked for *C. ensiformis* and *E. maximum*, whose the inhibitory effects promoted by the root fraction were always superior to the leaf fraction. Apparently, for the species of the Poaceae family, the leaf fraction is the preferential fraction as a source of chemical substances with inhibitory activity, while for species of the Fabaceae family there are variations. The informations available in the bibliography shows that plants produce and store chemical compounds with phytotoxic properties in different fractions, , with qualitative and quantitative variations in time and space.

Such characteristics can occur in both species of the same family, as among species of the same genus or even between varieties of the same species (HASSAN et al., 1998). Such variations were identified in this work for the species *E. sp.* and *E. maximum*, for example.

Table 2 Mean values of inhibition compared to the control of germination ($d_{(g)}$), elongation of the hypocotyl ($d_{(h)}$) and radicule ($d_{(r)}$) of *Mimosa pudica* depending on the extracts from fractions of the cover species.

		Plant fraction		
	Species	Leaves	Roots	Global
δ(g)	*Brachiaria brizantha*	32.67A d	28.33B c	30.50c
	Brachiaria decumbens	30.33A de	24.33B def	27.33de
	Brachiaria humidicola	31.67A d	27.67B cd	29.67cd
	Calopogonium mucunoides	53.67A b	33.00B b	43.33a
	Canavalia ensiformis	10.00B g	23.33A efg	16.67g
	Desmodium ovalifolium	27.33A e	19.67B g	23.50f
	Enterolobium maximum	18.00B f	32.33A b	25.17ef
	Enterolobium sp.	66.00A a	25.00B cde	45.50a
	Inga edulis	11.33B g	21.00A fg	16.17g
	Paspalum maritimum	50.00A b	12.00B h	31.00c
	Pueraria phaseoloides	19.33A f	15.33B h	17.33g
	Stylosanthes guianensis	42.67A c	37.33B a	40.00b
	Global	32.75A	24.94B	28.85
δ(g)	*Brachiaria brizantha*	27.00A b	15.33B cdef	21.17abc
	Brachiaria decumbens	18.33A d	13.67B def	16.00bcd
	Brachiaria humidicola	23.00A c	18.67B bc	20.83abc
	Calopogonium mucunoides	29.67A b	22.67B ab	26.17ab
	Canavalia ensiformis	15.00B de	26.00A a	20.50abc
	Desmodium ovalifolium	16.00A de	12.67B ef	14.33cde
	Enterolobium maximum	13.00A ef	15.33A cdef	14.17cde
	Enterolobium sp.	43.67A a	16.67B cde	30.17a
	Inga edulis	5.33B g	11.67A f	8.50de
	Paspalum maritimum	11.00B f	18.00A cd	14.50cd
	Pueraria phaseoloides	15.33A de	11.33B f	13.33cde
	Stylosanthes guianensis	3.67A g	3.00A g	3.33e
	Global	18.42A	15.42B	16.92
δ(g)	*Brachiaria brizantha*	41.67A c	31.00B ef	36.33c
	Brachiaria decumbens	38.33A cd	28.67B f	33.50de
	Brachiaria humidicola	39.00A c	33.00B de	36.00cd
	Calopogonium mucunoides	59.00A b	38.67B bc	48.83b
	Canavalia ensiformis	38.33B cd	61.67A a	50.00b
	Desmodium ovalifolium	34.67A de	28.67B f	31.67ef
	Enterolobium maximum	29.33B fg	41.67A b	35.50cd
	Enterolobium sp.	71.67A a	37.67B c	54.67a
	Inga edulis	26.33B g	35.33A cd	30.83f
	Paspalum maritimum	14.00B h	35.00A cd	24.50h
	Pueraria phaseoloides	31.67A ef	24.33B g	28.00g
	Stylosanthes guianensis	5.67A i	4.00A h	4.83i
	Global	35.81A	33.31B	34.56

Means followed by the same letters, uppercase in the row and lowercase in the column do not differ among each other by the Tukey test at 5% probability. Data are expressed in percentage of inhibition compared to the control.

Table 3 Mean values of inhibition compare d to the control of germination ($d_{(g)}$), elongation of the hypocotyl ($d_{(h)}$) and radicule ($d_{(r)}$) of *Senna obtusifolia*, depending on the extracts from the fractions of the cover species.

		Plant fraction		
	Species		Leaves	Roots
δ(g)	*Brachiaria brizantha*	26.00A c	14.33B bc	20.17bcd
	Brachiaria decumbens	24.33A cd	18.67B bc	21.50bcd
	Brachiaria humidicola	16.67A ef	14.00A bc	15.33cd
	Calopogonium mucunoides	36.67A b	19.33B b	28.00b
	Canavalia ensiformis	8.67B g	20.00A b	14.33cd
	Desmodium ovalifolium	20.67A de	9.33B c	15.00cd
	Enterolobium maximum	19.33A e	15.00B bc	17.17bcd
	Enterolobium sp.	18.00B ef	32.33A a	25.17bc
	Inga edulis	8.33B g	13.00A bc	10.67d
	Paspalum maritimum	46.33A a	38.00B a	42.17a
	Pueraria phaseoloides	14.67A f	10.67B bc	12.67d
	Stylosanthes guianensis	20.00A e	15.33B bc	17.67bcd
	Global	21.64A	18.33B	19.99
δ(g)	*Brachiaria brizantha*	16.33A bcd	11.00B de	13.67bcd
	Brachiaria decumbens	19.67A ab	14.00B cd	16.83bc
	Brachiaria humidicola	13.67A cde	11.00A de	12.33cd
	Calopogonium mucunoides	13.00A de	11.00A de	12.00cd
	Canavalia ensiformis	20.67B a	32.67A a	26.67a
	Desmodiu movalifolium	14.33A cde	10.67A de	12.50cd
	Enterolobium maximum	11.33A ef	14.00A cd	12.67cd
	Enterolobium sp.	16.33B bcd	20.33A bc	18.33bc
	Inga edulis	5.00B g	10.00A de	7.50d
	Paspalum maritimum	17.00B bc	22.67A b	19.83b
	Pueraria phaseoloides	9.33A f	6.67A e	8.00d
	Stylosanthes guianensis	9.33A f	6.67A e	8.00d
	Global	13.83A	14.22A	14.03
δ(g)	*Brachiaria brizantha*	30.67A cd	20.00B ef	25.33cde
	Brachiaria decumbens	31.00A cd	23.67B e	27.33c
	Brachiaria humidicola	19.00A g	17.67A fg	18.33def
	Calopogonium mucunoides	41.33A b	35.33B c	38.33b
	Canavalia ensiformis	52.67B a	62.33A a	57.50a
	Desmodium ovalifolium	24.67A ef	19.33B f	22.00cdef
	Enterolobium maximum	26.67B de	32.33A cd	29.50c
	Enterolobium sp.	34.33B c	41.67A b	38.00b
	Inga edulis	23.00B efg	28.33A d	25.67cd
	Paspalum maritimum	24.67B ef	34.67A c	29.67c
	Pueraria phaseoloides	18.67A g	15.00B g	16.83f
	Stylosanthes guianensis	21.00A fg	14.00B g	17.50ef
	Global	28.97A	28.69A	28.83

Means followed by the same letters, uppercase in the row and lowercase in the column, do not differ among each other by the Tukey test at 5% probability. Data are expressed in percentage of inhibition compared to the control.

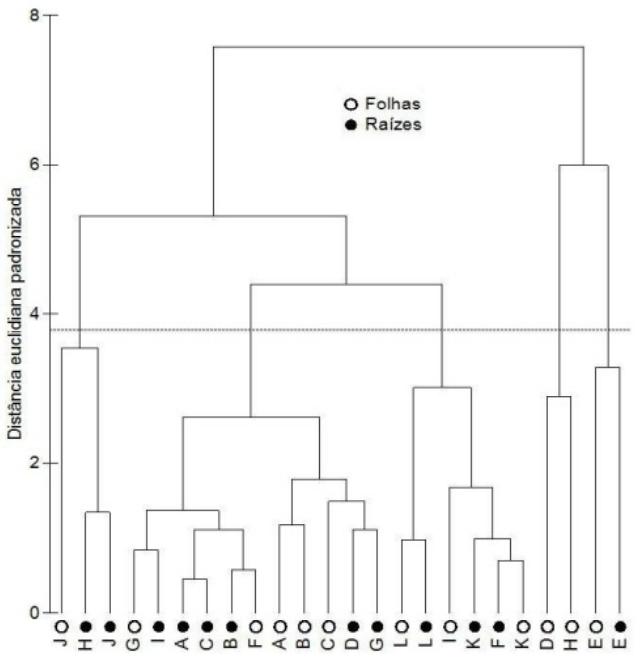

Figure 1 Dendrogram of dissimilarity between extracts evaluated. Where: A - *Brachiaria brizantha*, B - *Brachiaria decumbens*; C - *Brachiaria humidicola* D - *Calopogonium mucunoides*; E - *Canavalia ensiformis*; F - *Desmodium ovalifolium*, G - *Enterolobium maximum* H - *Enterolobium sp.* I - *Ingaedulis*, J - *Paspalum maritimum*; K - *Pueraria phaseoloides*; L - *Stylosanthes guianensis*.

Under field conditions, specifically for the hypothesis raised in this study, the results take relevant aspects in terms of strategic weed management based on the green cover. The reductions in the seed germination imply the dynamics of the population of the undesirable species, altering the flow of new individuals to the area of cultivation, while the reductions in the elongation of the radicule and hypocotyl reduce the competitive capacity of weeds by factors essential for survival, which favors in both cases, the plants cultivated, with positive effects on the performance and productivity of these.

Obviously, the manifestation of this favoritism is associated to the release of chemical compounds involved with the effects observed in this work for the environment. Information about the mechanisms involved in the release of allelochemicals to the environment can be found in the studies by Rice (1984), Tang (1986), Oleszek et al. (1992), among others. Aspects related to the dynamics of the allelochemicals

in the environment can potentiate or restrict the phytotoxicity (SOUZA FILHO and ALVES, 2002; TREZZI et al., 2006).

CLASSIFICATION AND ORDERING OF THE RESULTS

From the values of inhibition of germination and elongation from the hypocotyl and radicule, multivariate analysis was performed generating five groupings (Table 4 and Figure 2), represented by: $G_{(1)}$ *Paspalum maritimum* - both fractions; *Enterolobium sp.* - fraction root, $G_{(2.a)}$ *Brachiaria brizantha* - both fractions, *B. decumbens* - both fractions, *B. humidicola* - both fractions, *Enterolobium maximum* - both fractions, *Desmodium ovalifolium* - leaves fraction *Calopogonium mucunoides* - roots fraction and *Inga edulis* - root fraction, $G_{(2.b)}$ *Pueraria phaseoloides* - both fractions, *Stylosanthes guianensis* - both fractions, *I. edulis* - fraction leaf, *D. ovalifolium* - root fraction, $G_{(3.a)}$ leaf fraction of *C. mucunoides* and *Enterolobium sp.* G (3.b) *Canavalia ensiformis* - both fractions.

Table 4 Mean values of the indicators of inhibition from receptor species between the evidenced groupings

Receptor species	Inhibitors	Groupings					
		$G_{(1)}$	$G_{(2.a)}$	$G_{(2.b)}$	$G_{(3.a)}$	$G_{(3.b)}$	Global
Mimosa pudica	$\delta_{(g)}$	29.00	27.88	24.28	59.83	16.67	28.85
	$\delta_{(h)}$	15.22	17.70	8.56	36.67	20.50	16.92
	$\delta_{(r)}$	28.89	35.58	20.11	65.33	50.00	34.56
Senna obtusifolia	$\delta_{(g)}$	38.89	18.91	13.06	27.33	14.33	20.26
	$\delta_{(h)}$	20.00	13.30	7.94	14.67	26.67	14.03
	$\delta_{(r)}$	33.67	26.30	18.50	37.83	57.50	28.83
Number of extracts		3	11	6	2	2	24

The $G_{(1)}$ presented potential values of inhibition of germination and radicule elongation in malicia of the order of 29% and effective inhibitory values of 34-39% of the germination and radicule elongation in mata-pasto, while the group $G_{(2.a)}$ tended to effect of low inhibition values for both species, except for the effects observed in the radicule elongation of malicia, which showed inhibitory intensity of 36% (Table 4). The group $G_{(2.b)}$ tended to show inhibition values always below 20%, except for those on the germination of seeds (24%) and radicle

elongation (20%) of malicia (Table 4).

Among the five groups studied, the $G_{(3.a)}$ and $G_{(3.b)}$ were those that produced the inhibitions of greater magnitude, both in malicia as in mata-pasto, being the only ones to attend the value of 50% of inhibition proposed by Dudai et al. (1989). Comparatively, the group $G_{(3.a)}$ showed higher phytotoxic potential over malicia as the group $G_{(3.b)}$ tended to show greater specificity to the species mata-pasto (Table 4). Seeds germination and radicule elongation are preferentially inhibited by extracts of plants at intensities higher than those observed on the elongation of the hypocotyl, both for the case of malicia as well as for mata-pasto

From the non-metric multidimensional analysis (NMDS, *Non-metric multidimensional scalling*), which established new structure of higher affinity between the extracts evaluated (Figure 2), defining the following arrangements: $G_{(1)}$ - a small number of extracts evaluated, with low values of inhibition in *Mimosa pudica* and intermediate values of inhibition in *Senna obtusifolia*, $G_{(2.a)}$ and $G_{(2.b)}$ - large number of extracts evaluated, showing intermediate values of inhibition in *Mimosa pudica* and lower values in *Senna obtusifolia*, $G_{(3.a)}$ and $G_{(3.b)}$ - small number of extracts evaluated, high values especially in relation to germination and radicular inhibition in *Mimosa pudica* (Figure 2).

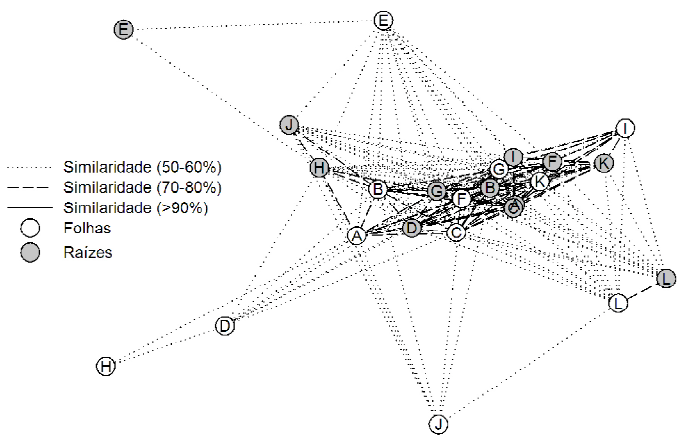

Figure 2 Topology of the affinity of the extracts obtained in non-metric multidimensional analysis. Where: A - *Brachiaria brizantha*, B - *Brachiaria decumbens*; C - *Brachiaria humidicola*, D - *Calopogonium mucunoides*; E - *Canavalia ensiformis*; F - *Desmodium ovalifolium*, G - *Enterolobium maximum*, H - *Enterolobium sp.*, I - *Inga edulis*, J - *Paspalum maritimum*; K - *Pueraria phaseoloides*; L - *Stylosanthes guianensis*.

Table 5 shows an indication of the degree of specificity and effectiveness of the fractions of each extract in relation to the inhibition of the germination, from the elongation of hypocotyl and from the radicule. The (ia) extracts from leaves of *Canavalia ensiformis*, *Paspalum maritimum* and *Stylosanthes guianensis* showed effective specificity in relation to inhibition of hypocotyl and radicule in *Senna obtusifolia.* With regard to germination, *Stylosanthes guianensis* showed effective specificity to *Mimosa pudica* and *Paspalum maritimum* presented the potential specificity to *Mimosa pudica*.

Now (ib) the fractions root from *Enterolobium maximum* and *Stylosanthes sp.* showed specificity to *Senna obtusifolia* with respect to the inhibition of the development of the hypocotyl and radicle. With respect to germination, *Enterolobium sp.* showed specificity to *Senna obtusifolia* and *Stylosanthes guianensis* specificity to *Mimosa pudica*. While (i.c.1) the radicular extract from *Paspalum maritimum* showed specificity concerning to germination, to *Senna obtusifolia* and (i.c.2) the radicular extract of *Canavalia ensiformis* showed specificity with respect to the germination, to *Mimosa pudica* and, with respect to inhibition of the hypocotyl, to *Senna obtusifolia*.

As for the (ii.a) leaf extracts from *Calopogonium mucunoides* from *Enterolobium sp.,* as well as both extracts of *Brachiaria humidicola* and *Pueraria phaseoloides* showed effective specificity to all inhibitors of *Mimosa pudica*. While (ii.b) both fractions from *Brachiaria brizantha* showed effective specificity or potential in all the inhibitors to *Mimosa pudica*. In (ii.c) both extracts of *Desmodium ovalifolium* and *Brachiaria decumbens* and radicules extracts of *Enterolobium maximum* and *Inga edulis* showed specificity to *Mimosa pudica* in relation to the inhibition of the germination and the radicle. While (ii.d) the radicular extract of *Calopogonium mucunoides* showed specificity to *Mimosa pudica*, in relation to inhibition of germination and hypocotyl (Table 5).

Regarding to the effectiveness of inhibition from the bioassays in *Mimosa pudica,* the (i.a) leaf fractions of *Calopogonium mucunoides* and *Enterolobium sp.* presented effectiveness in relation to inhibition of germination and radicle and potential effectiveness to inhibition of the hypocotyl. While (i.b) the leaf extracts of *Paspalum maritimum* were effective in relation to the inhibition of the germination and the radicular extract of *Canavalia ensiformis* presented effective for the radicular inhibition.

Table 5 Synoptic presentation of the specificity and effectiveness from the inhibition of germination, from the elongation from the hypocotyl and from the radicule in the extracts regarding the receptor species *Mimosa pudica* and *Senna obtusifolia*.

Extract		Specificity			Effectiveness					
					Mimosa pudica			*Senna obtusifolia*		
Species	Fraction	[G]	[H]	[R]	[G]	[H]	[R]	[G]	[H]	[R]
Brachiaria brizantha	Leaves	M(+)	M(++)	M(++)	(+)		(+)			(+)
	Roots	M(++)	M(+)	M(++)			(+)			
Brachiaria decumbens	Leaves	M(++)		M(++)	(+)		(+)			(+)
	Roots	M(+)		M(+)			(+)			
Brachiaria humidicola	Leaves	M(++)	M(++)	M(++)	(+)		(+)			
	Roots	M(++)	M(++)	M(++)			(+)			
Calopogonium mucunoides	Leaves	M(++)	M(++)	M(++)	(++)	(+)	(++)	(+)		(+)
	Roots	M(++)	M(++)		(+)		(+)			(+)
Canavalia ensiformis	Leaves		S(++)	S(++)			(+)			(++)
	Roots	M(+)	S(+)				(++)		(+)	(++)
Desmodium ovalifolium	Leaves	M(++)		M(++)			(+)			
	Roots	M(++)		M(++)			(+)			
Enterolobium maximum	Leaves						(+)			
	Roots	M(++)		M(++)	(+)		(+)			(+)
Enterolobium sp.	Leaves	M(++)	M(++)	M(++)	(++)	(+)	(++)			(+)
	Roots	S(++)	S(+)	S(++)			(+)	(+)		(+)
Inga edulis	Leaves									
	Roots	M(++)		M(++)			(+)			(+)
Paspalum maritimum	Leaves	M(+)	S(++)	S(++)	(++)			(+)		
	Roots	S(++)					(+)	(+)	(+)	(+)
Pueraria phaseoloides	Leaves	M(++)	M(++)	M(++)			(+)			
	Roots	M(++)	M(++)	M(++)						
Stylosanthes guianensis	Leaves	M(++)	S(++)	S(++)	(+)					
	Roots	M(++)	S(+)	S(++)	(+)					

[G] Inhibition of germination; [H] inhibition of hypocotyl elongation, [R] inhibition of radicule elongation, M = Mimosa pudica, S = Senna obtusifolia, (+) potential response, (+ +) effective response.

Now (i.c) the leaf extracts from *Brachiaria humidicola, Brachiaria decumbens* and *Brachiaria brizantha* and the radicule extracts from *Enterolobium maximum* and *Calopogonium mucunoides* showed potential effectiveness in relation to germination and the radicule development. In the case of (ii.a) *Stylosanthes guianensis*, in both fractions, was checked only potential effectiveness in relation to the inhibition of germination. While the (ii.b) leaf fractions of *Pueraria phaseoloides, Enterolobium maximum, Desmodium ovalifolium* and *Canavalia ensiformis* and the root fractions of *Paspalum maritimum, Inga edulis, Enterolobium sp., Desmodium ovalifolium, B. humidicola, B. decumbens* and *B. brizantha* showed only effectiveness potential in relation to the inhibition of

radicule development. The other extracts showed no character effectiveness or even potential.

About the effectiveness of inhibition verified in *Senna obtusifolia*, the (i.a), root extract of *Paspalum maritimum* showed effective potential compared to all inhibitors. While (i.b) the leaf extracts from *Calopogonium mucunoides* and radicle from *Enterolobium sp.* showed potential effectiveness of inhibition of germination and radicle. As for, the (i.c) radicle extract of *Canavalia ensiformis* presented effectiveness in relation to the inhibition of the radicle and potential effectiveness with respect to the hypocotyl inhibition. The (ii.a) leaf extract from *Canavalia ensiformis* showed effectiveness with respect to inhibition of the radicule, while the leaf extract of *Paspalum maritimum* showed effectiveness in relation to inhibition from the germination. In the case of (ii.b) leaf extracts *Enterolobium sp., Brachiaria decumbens and Brachiaria brizantha* and the radicule extracts form the *Inga edulis, Enterolobium maximum* and *Calopogonium mucunoides* was marked only potential effectiveness in relation to the inhibition of the radicule. The remainder of the extracts showed no effectiveness, not even potential.

Considering the whole set of results from this work and the possibility of using the species in the form of green cover in order to explore the allelopathy character in strategies of weed management in cultivation systems, it may be suggested that the different components of the family Fabaceae presented greatest potential for use, with particular emphasis on the species *Calopagonium mucunoides, Enterolobium sp.* and *Canavalia ensiformis.* Specifically for this last species, chemical substances with allelopathic activity have been reported by Santos et al. (2005). As for *Calopagonium mucunoides* and *Enterolobium sp.,* no studies were found with presentation of identified allelochemicals, although reports of allelopathic activity from extracts are found for the *Calopagonium mucunoides* species. These results assume also relevance when we know the potential of the fabeceae family in fixing nitrogen from the air.

However, the results presented by species from Poaceae were of smaller magnitude compared to the species from Fabaceae, which cannot be neglected, even because the species *B. humidicola* for example Souza Filho et al. (2005) isolated the compound p-coumaric acid, a potent allelochemicals, and for *B. brizantha*, Santos et al. (2008) isolated the compounds fridelina and epifridelinol, two allelochemicals from the group of triterpenes of low phytotoxicity. Of course, factors associated to the conditions of release and behavior in the environment may

determine a greater or lower activity of these whereas allelochemicals.

The relevance of the effects verified for *Paspalum maritimum* should be viewed with suspicion, given the character of formation of pure stands where this species vegetates and the difficulties in control, which can become a problem for the cultures of interest. The set of these results emphasizes that special attention should be focused on the allelopathic activity of species used in green culture, in the consolidation of strategies for weed control, especially concerning to mitigate the use of synthetic herbicides.

The Fabaceae species *Enterolobium sp*. and *Canavalia ensiformis* are annual, which means better compatibility to cover short-cycle crops such as rice, corn and others, whereas those species belonging to the Poaceae family and other Fabaceae species are from a long cycle, with greater compatibility, with perennial cultivations, such as fruiter, for example. In this context, the allelopathy phenomenon may have its effects more adequately utilized in the strategies of weed management in the system exploitation with green cover.

CONCLUSIONS

Under the conditions in which this work was carried out, it was possible to conclude that:

- Poaceae and Fabaceae showed different behavior in relation to the allelopathic effects, because the percentage of germination and elongation from hypocotyl of *Mimosa pudica* and *Senna obtusifolia* were lower in extracts of Fabaceae;
- The radicle elongation was lower when exposed to extracts of Poaceae;
- There was a tendency to leaf fractions presenting higher inhibitory effectiveness. The groups G (3.a) leaf fraction of *Calopogonium mucunoides* and *Enterolobium sp* and both fractions to G (3.b) *Canavalia ensiformis* were the ones that produced inhibitions in a greater magnitude.

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