Evaluación de extractos de fique, coquito, sorgo y ruda como posibles bio-herbicidas

Evaluation of cuban hemp, nut sedge, johnson grass and herb of grace extracts in weed control

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REC.: 05-03-08 ACEPT.: 05-03-09

RESUMEN

En experimentos completamente al azar en condiciones de laboratorio y campo, en Palmira, Valle del Cauca, se evaluó el efecto de extractos de ***Furcraea macrophylla*** Baker (fique), C*yperus rotundus* L (coquito), S*orghum bicolor* L (sorgo), y *Ruta graveolens* L (ruda) sobre la germinación de semillas de las arvenses *Bidens pilosa* L (papunga***)*** y *Amaranthus dubius* Mart (bledo) y del cilantro *Coriandrum sativum* L. Se obtuvieron los extractos por el método Soxhlet, utilizando agua, etanol y cloroformo como solventes. Los extractos obtenidos se evaluaron en tres diluciones (0, 5 y 10 %) en pruebas de geminación de semillas de las arvenses y del cultivo. Se utilizaron tres repeticiones de 50 semillas cada una y el testigo se regó con agua destilada.
Los extractos etanólicos y clorofórmicos de coquito y fique en las diluciones al 5 y 10 % presentaron el mayor efecto inhibitorio en la germinación a los 21 días. El ensayo de campo demostró el efecto inhibitorio de los extractos etanólicos de fique y coquito en la emergencia de las semillas del cilantro. El análisis de metabolitos secundarios comprobó la presencia de compuestos reportados como altamente tóxicos en fique y en menor cantidad en coquito, aunque los extractos de éste fueron los que más inhibieron la germinación.

Palabras clave: Alelopatía; *Macrophylla furcraea*; *Cyperus rotundus*; *Sorghum bicolor*; *Ruta graveolens*; *Bidens pilosa*; *Amaranthus dubius*; *Coriandrum sativum*; germinación; control arvenses.

ABSTRACT

The objective of this work was to evaluate the effect of the extracts of the species *Furcraea macrophylla* Baker (cuban hemp), *Cyperus rotundus* L (nut sedge), *Sorghum bicolor* L (sorghum) and *Ruta graveolens* L (common rue) on seed germination of two weeds (*Bidens pilosa* L (hariy beggarticks*), Amaranthus dubius* Mart (spleen amaranth)) and one crop (*Coriandrum sativum*

L (coriander)). The extracts were obtained by the Soxhlet method, using water, ethanol and chloroform as solvents. Each extract was evaluated in three dilutions (0, 5 and 10 % v/v). Three replications of 50 seeds each were used and the control was watered only with distilled water. The results showed that the ethanolic and chloroformic extracts of nut sedge and cuban hemp at two evaluated dilutions (5 and 10%) presented high inhibiting effect on the seed germination of the three species at 21 days. The field test verified the inhibiting effect on seed germination of the ethanolic extracts of cuban hemp and nut sedge on coriander**.** The secondary metabolite test showed the presence of compounds reported as highly toxic in Cuban hemp and in smaller amounts in nut sedge, although this species also greatly inhibited the seed germination.

Key words: Allelopathic; *Furcraea macrophylla* cuban hemp*; Cyperus rotundus* nut sedge*; Ruta graveolens* common rue*; Sorghum bicolor* sorghum; *Bidens pilosa* hairy beggarticks; *Amaranthus dubius* spleen amaranth; *Coriandrum sativum* coriander*;* germination; weed control.

INTRODUCTION

In crop production systems, weeds and the resistance of these to herbicides are important limiting factors to be taken into account in the use of combined control methods.

Allelopathy, the chemical process used by plants to reduce competition in their environment, offers a natural and environmentally friendly tool for weed management. Research offers possibilities for direct control of weeds, and also the development of new herbicides (Azim *et al*, 2005).

A wide range of species is potentially useful as natural herbicides, as they possess allelopathic chemical groups, including flavenoids, polyacetylenes, quinines and terpenes (mono- and sesqui-terpenes) (Kaufman *et al*, 1999; Putman, 1988). Among these species are reported *Sorghum bicolor* with high toxicity, and ability to control various weeds, such as *Amaranthus retroflexus (*Putnam *et al*, 1983); *Cajanus cajan* and *Mucuna deeringiana*, which reduced the population of weeds such as *Cyperus rotundus* to a level where the producers did not need to apply control measures (Hepperly *et al,* 1992); and the aqueous extracts of root exudates of Bermuda grass, which significantly inhibited germination and growth of cotton and the weeds, *Lagongchium*

farctum, Johnson Grass and *Xanthium strumarium* (Abdul-Rahman and Al-Naib, 1986).

In laboratory conditions, the monoterpenes, chemical constituents of the essential oils in some plants, significantly inhibited the germination and seedling growth of *Amaranthus retroflexus, Chenopodium album* and *Rumex crispus* (Kordali *et al*, 2007). Similar effects were reported with the essential oil of the common rue *Ruta graveolens (*De Feo *et al*, 2002).

Comparing the allelopathic effect of artemisinine, isolated from *Artemisia annua,* with commercial herbicides in nurseries of *Phaseolus aureus***,** Chen y Leather (1990) concluded that the natural extracts had the same level of inhibition as glyphosate.

Based on this, the present work aimed to evaluate the bioherbicide effect of extracts from *Furcraea macrophylla* Baker (Cuban hemp), C*yperus rotundus L* (nut sedge), S*orghum bicolor* L (sorghum) y *Ruta graveolens L* (common rue) on the germination of seeds of coriander *Coriandrum sativum* L and of the weeds *Bidens pilosa* L (hairy beggarticks***)*** y *Amaranthus dubius* Mart (spleen amaranth).

MATERIALS AND METHODS

The work was carried out in the Physiology and Phytochemical laboratories of the Experimental Center of the National University of Colombia, Palmira Campus (CEUNP). Plant material was gathered in the following manner: adult plant without flowers of *R. graveolens*; complete adult plant (with bulbs) of *C. rotundus*; harvest residues of *S. bicolor*; and the stalks of *F. macrophylla*. The material was chopped and ground once a humidity of 10% was obtained (50 °C for 72 hours). The crude extracts for a 20g sample were obtained using the Soxhlet extraction type.

Three factors were evaluated: species extracts (Cuban hemp, nut sedge, sorghum, common rue); extraction methods (ethanolic and chloroformic); and dilutions (2, 5 and 10%). To evaluate the inhibitory effect on seed germination of *A. dubius* (spleen amaranth) and *C. sativum* (coriander), the extracts of *F. macrophylla* and *C. rotundus* were used, as they were the treatments with the

greatest inhibitory effect in *B. pilosa.* The control was watered with distilled water.

The germination tests were carried out on sterile Petri dishes with 50 seeds, in a completely randomized design with three repetitions; the seeds were disinfected with an 75 % ethanol-water solution for one minute, submerged for the same time in a solution of 2 % hypochlorite-water solution; and were watered with 2 ml of the respective treatments, alternately with water. Periodic counts of the number of germinated seeds were made at 14, 16 and 21 days, differentiating normal (NP) from abnormal plants (AP) (ISTA, 1999). With the number of germinated seeds, the percentage germination was calculated.
The information was processed using S.A.S (Statistical Analysis System). Version 8.2 of 2002. The two species with the best results were analyzed for the qualitative detection of secondary metabolites (Palomino and Mier, 1995).

RESULTS AND DISCUSSION

Seed germination of *B. pilosa* showed highly significant differences compared to the control for extracts of *F. macrophylla* and *C. rotundus*, *S. bicolor* and *R. graveolens*, with reduced proportions of normal seedlings compared with abnormal seedlings; the extracts of *F. macrophylla and C. rotundus* presented the greatest inhibition (55.2%) in seed germination, and a high proportion of abnormal seedlings (10.3 and 23 %, respectively), supporting the phytotoxic effect. In seeds of *A. dubius,* the inhibitory effect of the metabolites of *F. macrophylla* and *C. rotundus* on the average germination was highly significant, with the *C. rotundus* extracts having the greatest inhibitory effect (Table 1).

The greatest inhibitory effect on germination (low proportion of normal seedlings and / or high proportion of abnormal seedlings) of *B. pilosa* and *A. dubius* was seen in extracts with the ethanol solvent. This is explained by the polar chemical nature of the extracted inhibitory compounds (saponins and coumarins). In the case of chloroform, it could be due to the action of extracted compounds of non-polar nature. Although aqueous extracts were significantly

different to the control, their inhibitory effect was less (Table 2), which could be due to the low concentration of metabolites extracted.

Table 1. Mean effect of extract (species) on germination of *B.pilosa* L., *A.dubius* L. and *Coriandrum sativum L*.

Extract	*B.pilosa*		*A. dubius*		*C. sativum*	
	Seedlings, % 1/					
	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Control	76.6 a	3.0	42.4 a	5.0 b	26.1 a	17.8 a
M. furcraea	21.4 c	10.3	27.8 b	10.2 a	5.4 b	7.2 b
C. rotundus	21.4 c	23.0	9.5 c	12.8 a	7.8 b	7.9 b
S. bicolor	50.0 b	3.6				
R. graveolens	46.8 b	12.2				

1/: Means with the same subindex in the same column are not significantly different at the level P< 0.05. The data were transformed a tang (x %) for the statistical analysis.

Table 2. Mean effect of solvent on seed germination in *B. pilosa L.*, *A. dubius* L. and *C. sativum* L.

Solvent	*B. pilosa*		*A. dubius*		*C. sativum*	
	Seedlings 1/					
	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Control	76.6 a	3	42.4 a	5.0 b	26,1 a	17,8 a
Chloroform	50.2 b	5.7	18.4 b	30.5 a	8.2 b	5.6 b
Ethanol	20.5 c	16.3	2.2 c	3.5 b	0.5 c	0.5 c
Water	30.5 b	17.4 b				

1/: Means with the same subindex in the same column are not significantly different at the level P< 0.05. The data were transformed a tang (x %) for the statistical analysis.

No significant differences were seen amongst the dilutions evaluated, although this was the factor that most affected germination (Table 3). The different effects of the substances and solvents on the germination are attributable to differences in concentration and chemical composition of compounds with recognized inhibitory activity, such as the coumarins, saponins and phenols,

amongst others, that inhibit mitosis, cellular elongation and oxygen absorption (Domínguez, 1973; Besnier, 1989).

Table 3. Mean effect of dilution on seed germination in *B. pilosa L*, *A. dubius* L. and *C. sativum* L.

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Dilution	*B. pilosa*		*A. dubius*		C. sativum	
	Seedlings, % 1/					
%	Normal	Abnormal	Normal	Abnormal	Normal	Abnormal
Control	76.6 a	3	42.4 a	5.0 b	26.1 a	17.8 a
2	58.8 b	3.2				
5	25.9 c	9.9	11.9 b	12.2 a	7.5 b	6.8 b
10	21.1 c	21.6	19.8 b	13.2 a	8.0 b	5.9 b

1/: Means with the same subindex in the same column are not significantly different at the level P< 0.05. The data were transformed a tang (x %) for the statistical analysis.

The extracts, solvents and dilutions showed highly significant effects on average germination of coriander seeds; the treatments in which ethanol was used as a solvent had the greatest inhibiting effect.

The phytochemical analysis corroborated that *F. macrophylla* had a large quantity of compounds (Table 4), some highly toxic to animals and plants, and to which the inhibitory effect could be attributed, as also registered by Besnier (1989), Sáenz and Bernal (2000) and by Forero (2000).

Although the extracts of *Cyperus rotundus* presented less variability and differences in compounds than those of *F. macrophylla,* the inhibitory effect on seed germniation was more notable, which may be attributed to the action of higher concentration of some metabolites (Besnier, 1989; Domínguez, 1973).

Table 4: Secondary metabolites in *Cyperus rotundus L* and *F. macrophylla* Baker

Substance	Test	Extract of *C. rotundus L*.		Extract of *F. macrophylla*	
		Ethanol	chloroform	Ethanol	chloroform
Alcaloids	Bouchardat	-	-	+	+
	Drangendorff	-	-	+	+
	Wagner	-	-	+	+
Coumarins	HCl	-	-	+	-
Steroids & triterpenoids	$CHCl_3$	+	-	-	+
Glicosides cardiotonics	Kebede A	-	-	-	-
	Kebede B	-	-	-	-
Tanines	FeCl3	+	-	+	+
Flavonoids	HCl	-	+	-	+
Saponins	Foam test	+	-	+	-

(-): Absence of metabolite; (+): Presence of metabolite.

CONCLUSIONS

Extracts of *F. macrophylla* Baker and *Cyperus rotundus* L in dilutions of 5 and 10% presented a greater inhibitory power on seed germination of *Bidens pilosa* L.

Ethanol was the solvent that presented the greatest effectiveness in the extraction of compounds with the ability to inhibit seed germination in the evaluated species.

All the evaluated treatments affected the germination of *Coriandrum sativum* L (coriander).

ACKNOWLEDGEMENTS

To the Research Division (DIPAL), and the Research Program in Genetic Resources of Medicinal, Aromatic and Spice plants of the National University of Colimba, Palmira Campus, and to Colciencias, for financing this study.

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